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Potential Effects of Winter Navigation on Movements of Large Land Mammals in Eastern Lake Superior and St. Mary's River Area

Great Lakes-St. Lawrence Seaway Navigation Season Extension Program

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The purpose of this supplemental study was to provide an additional field season to determine variability in movement of mammals studied during the winter of 1979-80 and to obtain more specific information particularly on the movements of two species, the wolf (Canis lupus) and the white-tailed deer (Odocoileus virginianus). The supplemental report provides this additional data.

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SUPPLEMENTAL REPORT
TO

POTENTIAL EFFECTS OF WINTER NAVIGATION ON MOVEMENTS OF LARGE LAND MAMMALS IN THE EASTERN LAKE SUPERIOR AND ST. MARY'S RIVER AREA 1980 - 1981

by

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Modification of
Contract No. 14-16-0009-79-053

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PREFACE

This is a Final Supplemental Report on the Modification of Contract Number 14-16-0009-79-053 between Northern Michigan University and the Department of Interior, United States Fish and Wildlife Service. The objectives of the original study (Robinson and Fuller 1980) conducted during the winter of 1979-80, were to determine: (1) the species and relative numbers of mammals that used the ice of the St. Mary's River and Whitefish Bay for travel, (2) the locations most commonly used for travel, (3) the purpose of using the ice such as migration, traveling directly across the ice, traveling along the ice, or foraging on the river or bay, (4) whether animals would swim across open water in winter, and (5) potential effects of winter shipping on the movements of mammals on the ice.

After a single winter's study, it was recognized that further information was needed on movements and behavior of deer in and about their winter deer yard on Neebish Island where frequent channel crossings occurred and on densities of wolves in Ontario in the vicinity of Whitefish Bay and the St. Mary's River. Also, because of a possible lingering effect of winter demonstration shipping between 1972 and 1979, it was recommended in the 1980 report that winter shipping be discontinued for at least three consecutive winters to allow animals to adjust their behavior to non-shipping conditions, so that data gathered on mammal movements on the ice might be more representative of baseline conditions.

The purpose of the modification of the contract was to provide an additional field season to determine variability in movements of mammals studied during the winter of 1979-1980 and to obtain more specific information, particularly on the movements of two species, the wolf (Canis lupus) and the white-tailed deer (Odocoileus virginianus).

EXECUTIVE SUMMARY

Field studies were conducted during the winter of 1980-81 to supplement studies conducted the previous winter on mammals crossing the ice of Whitefish Bay and the St. Mary's River. The objectives of the supplemental study were to augment information on possible variability in numbers, locations, and species of animals crossing the ice, to obtain more detailed information on densities of wolves in Ontario, to describe numbers and movements of deer in the population wintering on Neebish Island, to assess the impact of winter shipping on wolves and deer, and to compare such impact with other causes of mortality.

Methods used included aerial and ground surveys of tracks, interviews with Canadian trappers on locations and numbers of wolves, radio-tagging and releasing five deer, interviews with Neebish Island residents on hunting mortality, and systematic survey for dead deer and browse available to deer.

Weather conditions were characterized by deep snow and cold temperatures in December and early January followed by little snowfall and melting temperatures making for poor tracking conditions through much of the winter. No commercial shipping (with a single exception) occurred from January 1 - March 24.

During the January 15 - March 23 period, 128 sets of tracks were counted crossing the ice of the St. Mary's River. Of these, 105 (82%) were of white-tailed deer, 10 (8%) were of coyote, 8 (6%) were of dogs, 4 (3%) were of unknown canids, and 1 (1%) was of a fox. Adjusting for days on which tracks made were not counted, we estimated a total of 441 crossings by deer, 32 by coyotes, 24 by dogs, 8 by unidentified canids, and 4 by foxes.

On Whitefish Bay from January 11 to March 26, 175 sets of tracks were counted farther than 10 m from shore. Of these, 96 (54%) were of coyotes, 1 (1%) was of red fox, 50 (29%) were of unknown canids, 14 (8%) were of moose, 14 (8%) were of snowshoe hare, 1 (1%) was of a weasel, and 1 (1%) was of red squirrel. From these, accounting for days on which sampling could not be done, we estimated a total of 6,951 animal forays onto the ice of Whitefish Bay during the study period. No tracks were known to cross the bay, but maximum distances from shore were 5.7 km for a coyote, 3.8 km for a fox, 4.0 km for a snowshoe hare, and 3.0 km for a weasel. It is likely that some animals went from shore to shore but poor tracking conditions prevented verification of this.

As in 1980, mammal crossing rates of both Whitefish Bay and the St. Mary's River was highest in January and March and lowest in February.

Locations of all but three deer crossings on the St. Mary's River were adjacent to Neebish Island. Migration from Sugar Island to Neebish in January was indicated by five tracks (adjusted to an estimated total of 43 crossings from Sugar to Neebish Island with none recorded going the other way. Near Johnson Point, 97 tracks were observed crossing the channel to and from St. Joseph Island. These were believed to have been made by about 12 deer seeking food on St. Joseph Island.

The effects of winter shipping on deer movements as in 1980 were again demonstrated in 1981. Ten turnbacks of deer at the ship track were recorded, six in January of deer attempting to cross from Sugar to Neebish Island, the remainder at Johnson Point (see figure 3). Turnbacks all occurred more than 24 hours after ship passage, probably because of the high ice ridge created by December shipping with thick ice. In the Johnson Point area, the ice ridge was nearly up against the Rains Island shore. Thus, some turnbacks of deer may have occurred before the deer stepped onto the ice and, therefore, may have gone unrecorded.

An estimate of 300-500 deer was made for the Neebish Island population. The winter mortality of 37 deer (7-15 percent) was small, by comparison with that in other Upper Michigan areas in other winters. Mild weather in February and March permitted deer to find food earlier than normal.

Five fawn were radio-collared on Neebish Island in February and March. Winter movements of these deer covered less than 1.5 km^2 and none was known to cross the river in winter. In April, one deer moved to Sugar Island by swimming and established a summer range on east central Sugar Island, 14 km from its capture site. Four deer established summer ranges in the northern portion of Neebish Island, about 9 km from their winter range. As of mid-July, the transmitters on these deer continued to function.

Judging from trapper interviews and a few track observations, a population of 18-25 wolves was estimated to occupy areas within 30 km of Whitefish Bay and the St. Mary's River. The only wolf population that is apparently growing is on Cockburn Island, about 30 km east of the shipping channel in the lower St. Mary's River.

On March 4, two wolves ventured onto the ice off the southern tip of St. Joseph Island headed southwesterly, but turned back east to cross Drummond Island and eventually to Cockburn Island. They had been within 2 km of the ship track in De Tour Channel when they turned back. By coincidence, the Coast Guard Icebreaker Mackinaw was then anchored in the ice in this channel location that night. The effects of winter shipping on wolf movements across the ice are believed to be negative, based upon literature reviewed and the observation described above. The presence of a ship or recent scents of its passage may have caused the wolves to retreat as in the case of the Mackinaw in De Tour Passage.

The probability of wolves crossing the ship track is estimated on the basis of current wolf densities and movements at perhaps one wolf every ten years in the Whitefish Bay area and perhaps one per winter on the lower St. Mary's River. These estimates assume relatively constant wolf densities.

Recommendations for further investigation of mammal movements and the effects of winter shipping should include the following: (1) a third season of collecting mammal track data in the absence of winter shipping, (2) continuation of monitoring deer population and movements from the Neebish Island yard by radio telemetry to obtain further information on their summer and fall range, (3) obtain more data on numbers and movements of wolves on Cockburn Island, the area from which wolf dispersal across the shipping channel appears most likely, and (4) periodic assessments of possible increases or decreases in wolf numbers on the Ontario mainland.

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PART I: INTRODUCTION

Mammals that are active in winter may depend upon moving across ice in winter to maintain traditional migratory patterns, disperse into new terrain, or to obtain seasonal resources such food or cover (Robinson and Fuller 1979). Winter shipping on the St. Mary's River and Whitefish Bay has the potential of disrupting such movements.

In the winter of 1979-80, Robinson and Fuller (1980) studied the activity of seven species of large mammals through track observations on the ice of the St. Mary's River and Whitefish Bay. They estimated 1,743 crossings of the St. Mary's River in January-March 1980. Of these, 51% were by white-tailed deer, 15% were by coyotes (<u>Canis latrans</u>), 6% by red foxes (<u>Vulpes fulva</u>), 5% by domestic dogs (<u>Canis familiaris</u>), 7% by unidentified canids, and 15% by unidentified mammals. One track of bobcat (Lynx rufus) was observed and none of wolf, lynx (<u>Lynx canadensis</u>), or moose (<u>Alces alces</u>) were found on the St. Mary's River. On Whitefish Bay, where snow, wind, and ice conditions made systematic collection of track data difficult, tracks of a group of five wolves were seen near an island 6.6 km from the Ontario mainland and 17 km from the shipping route. No other wolf sign was found in 1980.

In February and March 1980, after passage of a few vessels, observations and tracks revealed that deer were unable to cross the vessel track within 24 hours after passage. Coyotes and foxes, however, seemed little affected by ship passage. Literature reviewed suggested that wolves are diverted by ice ridges, but no information on specific effects of shipping on wolf movements could be found.

It was thought that more intense effort should be directed toward investigating the use of the ice of the St. Mary's River by deer. The endangered status of the wolf in the United States and the possibility of immigration of wolves into Michigan from Ontario suggested that more information should be obtained on wolf densities and ranges in the area. Therefore, a modification of the 1979-80 contract with an extension to October 1981 was granted to meet the following objectives:

1. To determine density of wolves in the vicinity of Whitefish Bay.

2. To estimate the frequency of wolves crossing Whitefish Bay and the St. Mary's River.

3. To estimate the potential effects of winter shipping on wolf movements in the Whitefish Bay-St. Mary's River area.

4. To estimate the number of deer wintering in the vicinity of Neebish Island and its surrounding channels.

5. To estimate the number of deer which cross the ship channel on the ice during the January-March period.

6. To determine the range which deer wintering on Neebish Island occupy at other seasons.

7. To assess the potential effect of winter shipping on deer populations, both locally and regionally, utilizing available information including annual recruitment and mortality other than from winter shipping.

8. To monitor and assess the impacts of winter shipping on other mammal movements on the ice of Whitefish Bay and the St. Mary's River.

PART II: THE STUDY AREA

The study area (Figure 1) includes Whitefish Bay, which is the easternmost part of Lake Superior, and the St. Mary's River, which flows from Lake Superior to Lake Huron. Whitefish Bay covers about 1,650 km^2 and is 50 km long from Whitefish Point to its outlet into the St. Mary's River. The river is 101 km long and varies in width from 0.7 to 7.0 km. Four large islands, Sugar, Neebish, St. Joseph, and Drummond range from 50 to 380 km^2 in area.

The Canadian side of Whitefish Bay is largely wooded with summer resorts and cabins along the immediate shoreline. The U.S. side is also wooded but has more permanent residents on the shoreline. Both shores of the St. Mary's River have been variously developed for agriculture and recreational housing but also include several tracts of undeveloped forested land extending more than 8 km long.

The cities of Sault Ste. Marie, Ontario, (population 85,000) and Sault Ste. Marie, Michigan (population 15,000) are the only large urban centers in the area. They are located directly across from each other on the northwestern portion of the river and occupy about 10 km of shoreline on both sides.

Weather

Based on the statistics compiled at Sault Ste. Marie, weather conditions during the winter of 1980-81 were more severe than average during January and the first half of February, and less severe than average during the last half of February and March (Table 1). On the whole, temperatures for the January-March periods were 0.4 C colder than average, and total snowfall of 142.1 cm in the period was 14.2 cm below normal. Unseasonably warm temperatures in late February and early March allowed much of the precipitation to fall as rain. This quickly reduced the mean daily snow depth from 60.4 (27% above the normal) during the first half of February to 28.3 cm (32% below the normal) in the first half of March. Weather conditions in December were marked by large amounts of snowfall. Travel by resident mammals was therefore probably more impeded during the first half of the winter, and less impeded during the last half of the winter than would occur under "normal" conditions. The total freezing degree days recorded for the winter of 1980-81 was 1937 compared with the 81-year average of 1815.

Ice Conditions

Cold temperatures in December caused thick ice formation earlier than in 1979-80. By 10 January, when our field studies began, typical mid-winter ice had formed. Whitefish Bay southeast of Whitefish Point was entirely ice covered with the exception of a few patches where upwellings and currents keep the surface ice-free throughout the winter. Open water also remained between the cities of Sault Ste. Marie, Michigan and Ontario. Downriver open water remained only as a patch of several hectares in East Neebish Channel at the Sugar Island Ferry in the Rock

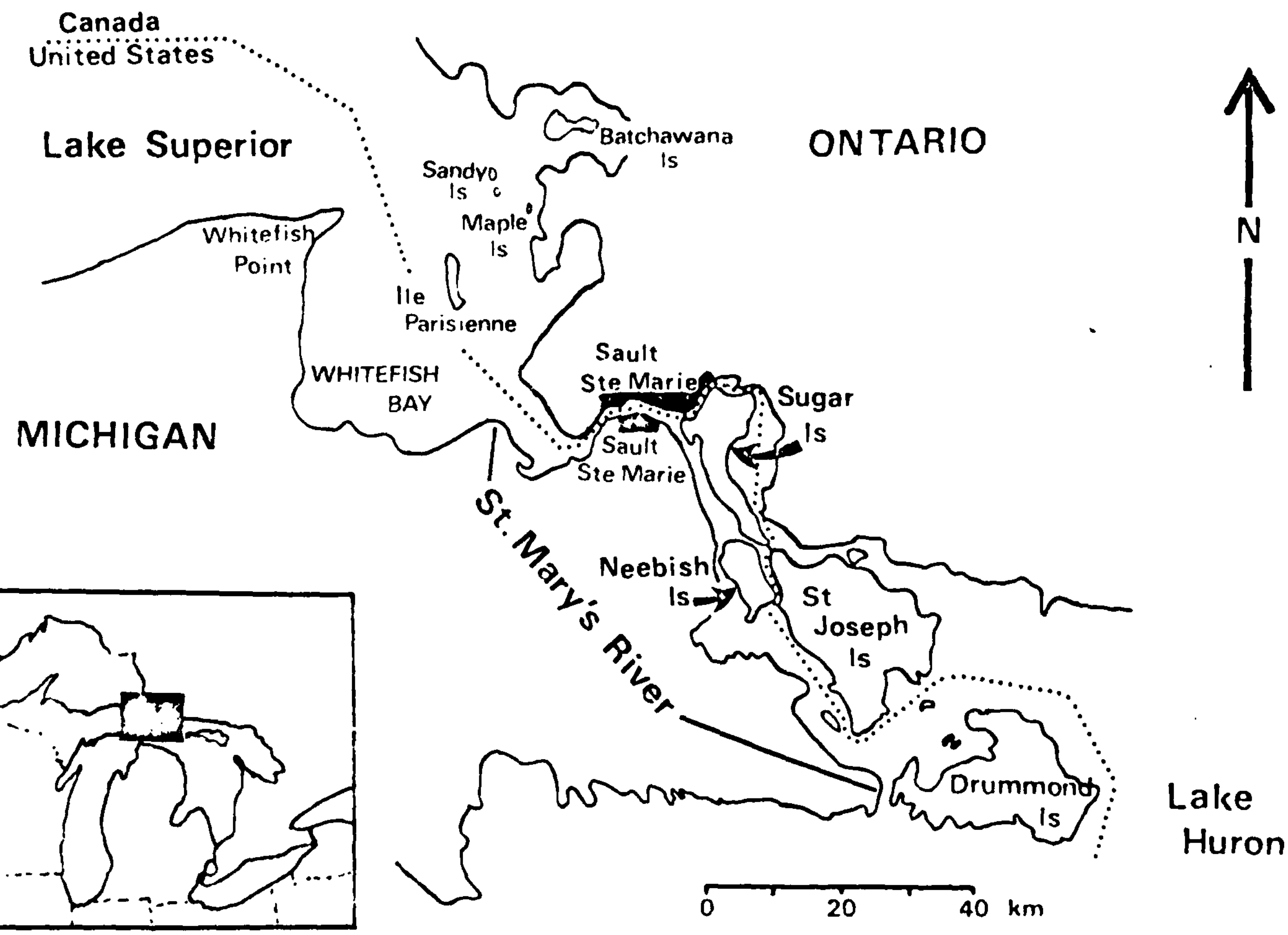

Figure 1. Map of the St. Mary's River-Whitefish Bay Study Area.

Table 1. Summary of Weather Data Recorded at Sault Ste. Marie, Michigan Municipal Airport (National Weather Service).

Weather Parameter	January 1-14	January 15-31	February 1-14	February 15-28	March 1-15	March 16-31	Mean or Total
Mean Daily Temp. (C) 1981	-18.7	-8.5	-14.8	0.4	-4.0	-0.2	-7.5
1941-70	-9.9		-9.3		-4.4		-7.9
Cumulative Freezing Degree Days (F)	704-1144	1144-1405	1405-1779	1779-1778	1778-1911	1911-1937	1937
Mean Daily Snow Depth (cm) 1981	57.9	50.9	60.4	44.3	28.3	16.7	42.6
1942-78	29.9	38.7	47.7	47.7	41.4	23.7	37.9
Total Snow Fall (cm) 1981	29.0	5.6	58.9	17.0	21.2	10.4	142.1
1942-78	68.6		49.3		38.4		156.3
% of Days Snowfall ≥ 2 cm - 1981	48	6	50	21	20	12	24
Mean Daily Wind Speed (km/hr) 1981	12.1	12.2	15.3	14.6	16.6	13.3	14.0
1941-70	12.2		15.8		16.6		16.2
% of Days Wind Speed ≥12 km/hr 1981	43	41	57	71	87	56	59
Average Sky Cover (%)1981	69	65	78	84	74	70	73
1941-70	80		74		69		74
% of Days Cloud Cover ≥50% 1981	71	76	86	93	87	81	82

Cut of West Neebish Channel and for about 1.5 km upstream from the Drummond Island Ferry Crossing.

The combination of heavy ice and shipping in December created unusually thick ice ridges along the ship track. Chunks of ice up to 0.5 m thick pushed up by ice breakers and passing ships created jagged ridges up to 1 m high in places along the ship track. These ridges were gradually eroded by sunshine, wind, rain, and melting temperatures during late January and late February.

In mid March, open water began to expand gradually. When commerical shipping began on 25 March, ice broke up rapidly.

In summary, ice conditions were generally favorable for mammal movements throughout the winter, except for occasional snow-free and slippery ice and thick ice ridges along the ship track which made traveling by hooved animals difficult (Robinson and Fuller 1980).

Winter Shipping

In the winter of 1980-81, commercial shipping in the study area ceased on 31 December and resumed 25 March. On 4, 9, and 20 January, the U.S.S. Katmai Bay, a U.S. Coast Guard icebreaker, made trips downriver from Sault Ste. Marie as far as Lime Island. On 10 January, the U.S.S. Westwind, a larger icebreaker, traveled upstream from Detour to Sault Ste. Marie and returned downstream the same day. On 4 February, the U.S.S. Westwind and U.S.S. Machinaw broke ice from Detour to Sault Ste. Marie and returned downstream 5 February. Four icebreakers broke ice for an oil barge traveling upstream to Sault Ste. Marie on 3 March. All five ships returned downstream on 4 March. Commercial shipping began 25 March and by 2 April the river was ice free from Sault Ste. Marie to the southern tip of Neebish Island.

PART III: METHODS

Aerial Surveys

Aerial surveys were usually made in a ski-equipped Piper PA-12 or PA-18 Supercub aircraft. On 24 and 25 March, after warm weather prohibited the use of ski-equipped planes, a wheeled Cessna Skyland II was used. On most flights, two observers were present in addition to the pilot.

Tracks were observed by flying slowly (130-150 km/hr) at an altitude of about 45-75 m above the ice. One or two of three weather conditions hindered successful observation of tracks on 67 of 75 days. These conditions included falling snow or recent snowfall greater than 3 cm, winds greater than 12 km/hr, which obliterate tracks made previously, and cloud cover greater than 50%, which eliminates shadows, causing poor contrast for seeing tracks. Weather conditions also frequently varied within the study area. The location and topography of Whitefish Bay made this area highly vulnerable to being windswept and prone to lake snow. The logistics of getting to certain remote sections of the shoreline also presented some difficulty. For these reasons, coverage of the area by aerial and ground surveys was unequal, depending upon the presence of proper flying weather and tracking conditions.

On Whitefish Bay, aerial surveys were conducted along 66 km of Canadian shoreline between Gros Cap and Corbeil Point (Figure 2). An estimated 54 km of shoreline surrounding Batchawana Island, North and South Sandy Island, Maple Island and Ile Parisienne were also surveyed. Some reaches of shoreline were not sampled due to excessive human and dog activity and the area northwest of Corbeil Point was not surveyed due to a lack of ice cover. Aerial surveys covered 80 km of the shipping channel on the St. Mary's River beginning at the northwest corner of Sugar Island and ending at the southern tip of St. Joseph Island. Returning upstream 21 km of non-shipping channels, West and East Neebish channels were surveyed. Only five aerial surveys were made this winter because of poor tracking and flying conditions. All tracks seen from the air were verified from the ground.

Track Identification From the Air

After recording tracks from the air, known track patterns were verified on the ground. Wild canids were distinguisehd by the characteristic patterns of such tracks appearing as a single file of dots across the ice (Murie, 1954). Fox, coyote, and timber wolf were identified by the difference in size of the track and the distance between prints. Fox and coyote tracks presented the greatest difficulty in identification; therefore, several tracks were simply recorded as canid when we were unable to determine the exact species. When tracks were thought to be of timber wolf, every effort was made to verify them from the ground.

From the air, moose tracks appeared similar to human prints in shallow snow, but in deeper snow they appeared as large parallel alternate dashed lines. This pattern resulted from dragging their

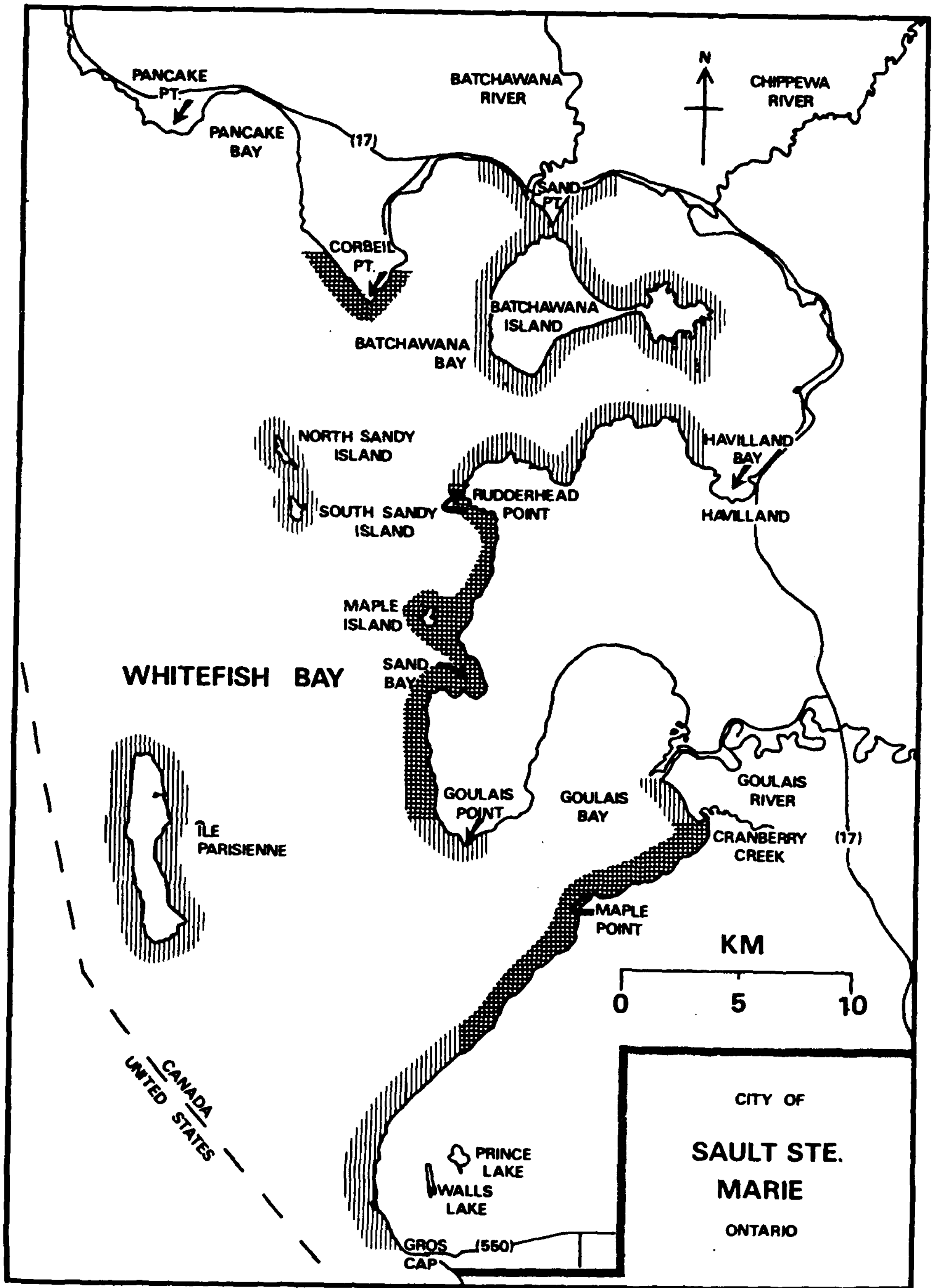

Figure 2. Map of shoreline of Whitefish Bay, Ontario, showing those sections surveyed by air (shaded), air and ground (cross-hatched) and those unsurveyed (clear).

Table 2. Summary of Aerial and Ground Survey Efforts During Studies of Mammal Movements on the ice of Whitefish Bay and the St. Mary's River, 9 January to 30 March 1981.

	January	February		March		
	10-31	1-14	15-28	1-15	16-31	Total
No. of aerial surveys	4	2	2	3	3	14
Total no. of Hours	8.5	5.2	3.8	4.4	5.1	27.0
No. of km surveyed on the ground						
-on the ice	40.8	8.4	4.0	20.9	28.4	102.5
-in adjacent wooded areas	32.0	14.5	23.5	30.4	33.6	134.0
Total	72.8	22.9	27.5	51.3	62.0	236.5

Table 3. Number of Days Each Shoreline segment on Whitefish Bay Study Area was Surveyed from the Air and from the Ground, 10 January to 25 March 1981.

Shoreline segment	No. of aerial surveys	No. of ground surveys
Gros Cap to Maple Point	6	1
Maple Point to Goulais River	7	3
Goulais Point to Sand Bay	7	1
Sand Bay to Rudderhead Point	7	3
Rudderhead Point to Havilland Bay	7	0
Sand Point to Batchawana Bay	7	0
Batchawana Govt. Dock to Corbeil Point	7	1
Maple Island	8	1
Batchawana Island	8	1[a]
North Sandy Island	8	0
South Sandy Island	8	1[a]
Ile Parisienne	8	1[a]

[a] Brief visit by landing plane.

hooves. Often several wild canids, as well as moose, would follow each other in the same footprints, but would periodically separate for a short distance and thus were identifiable as being more than one animal. Tracks of short-tailed weasel (Mustela erminea), snowshoe hare (Lepus americanus), and red squirrel (Tamiasciurus hudsonicus) were occasionally seen on the ice and were unique and easily identified (Murie 1954).

Ground Surveys

Ground surveys were conducted as a check of aerial surveys and to allow more detailed observations of tracks in remote areas where wild canid tracks were common. These surveys were usually conducted on days following aerial surveys (Table 2). Sections of the shoreline were traveled by walking, skiing, or snowshoeing. Two sections of shoreline on Whitefish Bay were surveyed most often, the western portion of the Goulais Peninsula between Rudderhead Point and Goulais Bay and between Cranberry Creek and a point directly south of Goulais Point (Figure 2) (Table 3). Inland areas surveyed consisted of a moose wintering area near Sand Bay, and the deer yard near Walls Lake (Figure 2).

On the St. Mary's River, ground surveys were conducted on Middle Neebish and Munoscong Channels (Figure 3). Surveys were conducted on St. Joseph Island between Whiskey Point and a marsh 3 km south of Hay Point, and on Drummond Island between False Point and Pilot Cove. Moose wintering areas on Southern St. Joseph Island and deer yards around Bass Lake on Drummond Island were also surveyed (Figure 4).

Data Recorded

The same track information, recorded by Robinson and Fuller during winter 1979-80, was recorded in 1980-81. This included species, aerial or ground observation, date, time of day, location of starting and ending points of tracks, number of animals in a group, whether the animal was seen or not, estimated age of track, direction of travel, whether the tracks crossed the channel or not, type of movement (i.e., meandering or traveling perpendicular or parallel to shore), channel width, distance animals traveled on the ice, onshore depth of tracks in snow, minimum depth of track in snow on the ice, time since last snowfall or strong wind, ice conditions, snow condition, habitat type, and time since ship passage. During surveys of inland areas, similar data were recorded on all moose and possible timber wolf tracks. Data on all tracks recorded are given in Appendix A.

Interviewing Trappers and Others About Timber Wolf Activity

The Ontario Ministry of Natural Resource Offices (OMNR) supplied the names and addresses of all the trappers with traplines on crown land, those who had written permission to trap on private land, those who were reported to have trapped timber wolves in the past, and Indians who hunt and trap on the reserves within our study area in Sault Ste. Marie and Espanola, Ontario. The Sault Ste. Marie Chapter of the Ontario Trappers Associated was also contacted, and Jenson and Hautala attended the 7 February meeting. An attempt was made to personally contact each individual and inform them of the study. From 9 January to 28 February,

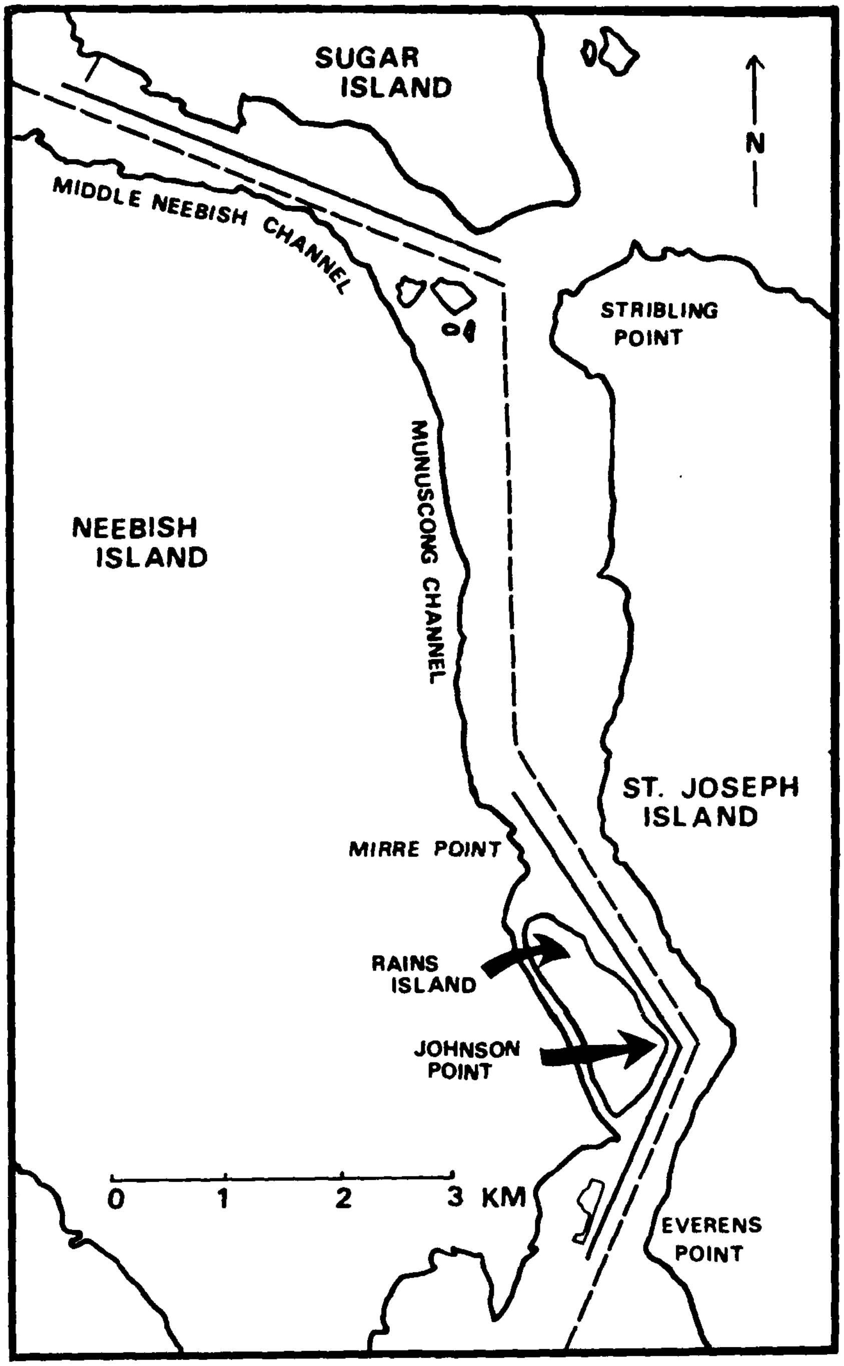

Figure 3. Map of Neebish Island area showing channel segments surveyed from the ground (solid lines). Shipping channel is shown by a dashed line.

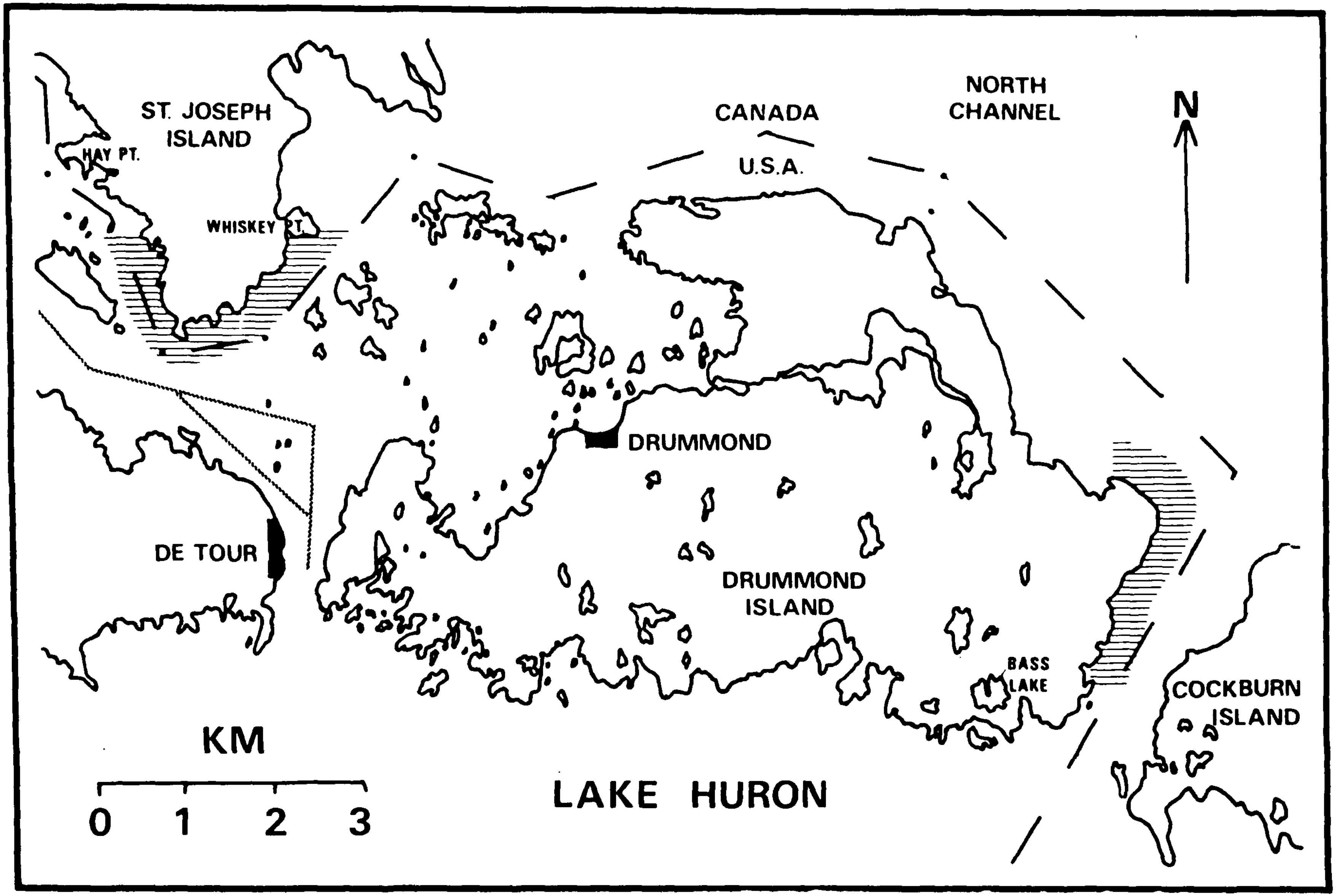

Figure 4. Map of southern St. Joseph, Drummond and western Cockburn Island. Shaded areas denote shoreline that was surveyed on the ground.

an offer of $300 in United States currency was made to all the trappers for live timber wolves in good condition captured within 25 km of Whitefish Bay or the St. Mary's River. During those conversations an attempt was made to subjectively evaluate the individuals experience as a trapper and his/her knowledge of timber wolves. We began by stating that we were only interested in timber wolves and not "small" or "brush" wolves (coyotes). The trapper was then asked if he knew of or had seen sign (i.e., tracks, scats, kills) of timber wolves on his trapline. If they had, the exact location was marked on a map of the area. The reported size of the track was used as a means to verify that the individual was not confusing coyote tracks with those of the timber wolf. Additional questions included: the date the sign was last seen, number of animals, direction of travel, presence of kills, hearsay about wolf activity from other trappers in the area, and the names and addresses of other persons (i.e., bait dealers, loggers) in the area that are known to spend time in the woods. The information collected was recorded and the additional persons suggested were contacted.

In Michigan, the names of local trappers and fur dealers were obtained by contacting the Sault Ste. Marie area Wildlife Biologist for the Department of Natural Resources, Tom Weise. These people were not offered money for the capture of timber wolves but were asked questions similar to those asked trappers in Canada. Commercial fishermen, the local Naturalist Club, sporting goods, hardware, and grocery store owners, snowmobile dealers, and members of the Bay Mills Indian Tribe were contacted and asked to notify us if they had information about timber wolves or moose activity on the ice of Whitefish Bay and the St. Mary's River.

Trapping and Radio-collaring Deer

In order to mark and radio-track deer, two Stevenson-type box traps (Bartlett 1932) were constructed and set on Southern Neebish Island (Figure 5). The first trap was operational 22 January and the second trap 5 February. The traps were baited with freshly cut cedar and checked each day. Each trap operated 56 days. Trap #1 was dismantled on 27 March and trap #2 on 9 April.

Physical data collected for trapped deer included: age, sex, hind foot length, neck and chest girth, and estimated weight. Each trapped animal was fitted with a radio-transmitting collar (Advanced Telemetry Systems, Inc.), two Michigan DNR metal ear tags, and a nylon collar with a colored, numbered cattle tag attached.

Monitoring Radio-collared Deer

Movements of radio-collared deer were recorded by tracking from the ground (Marshall and Kupa 1963) and from an airplane (Mech 1974) during the winter, spring, and summer 1981. The amimals were located by triangulation from the ground. Compass readings of the direction of the strongest signal were taken from two points. The azimuths were then plotted on maps and the intersection of the two lines located the animal. This method was found to be accurate within 0-2.2 hectares (Heezen and Tester 1967). The range of effective signal reception from ground locations was about 2 km in the winter which declined to about 1 km in the summer because of increased foliage density.

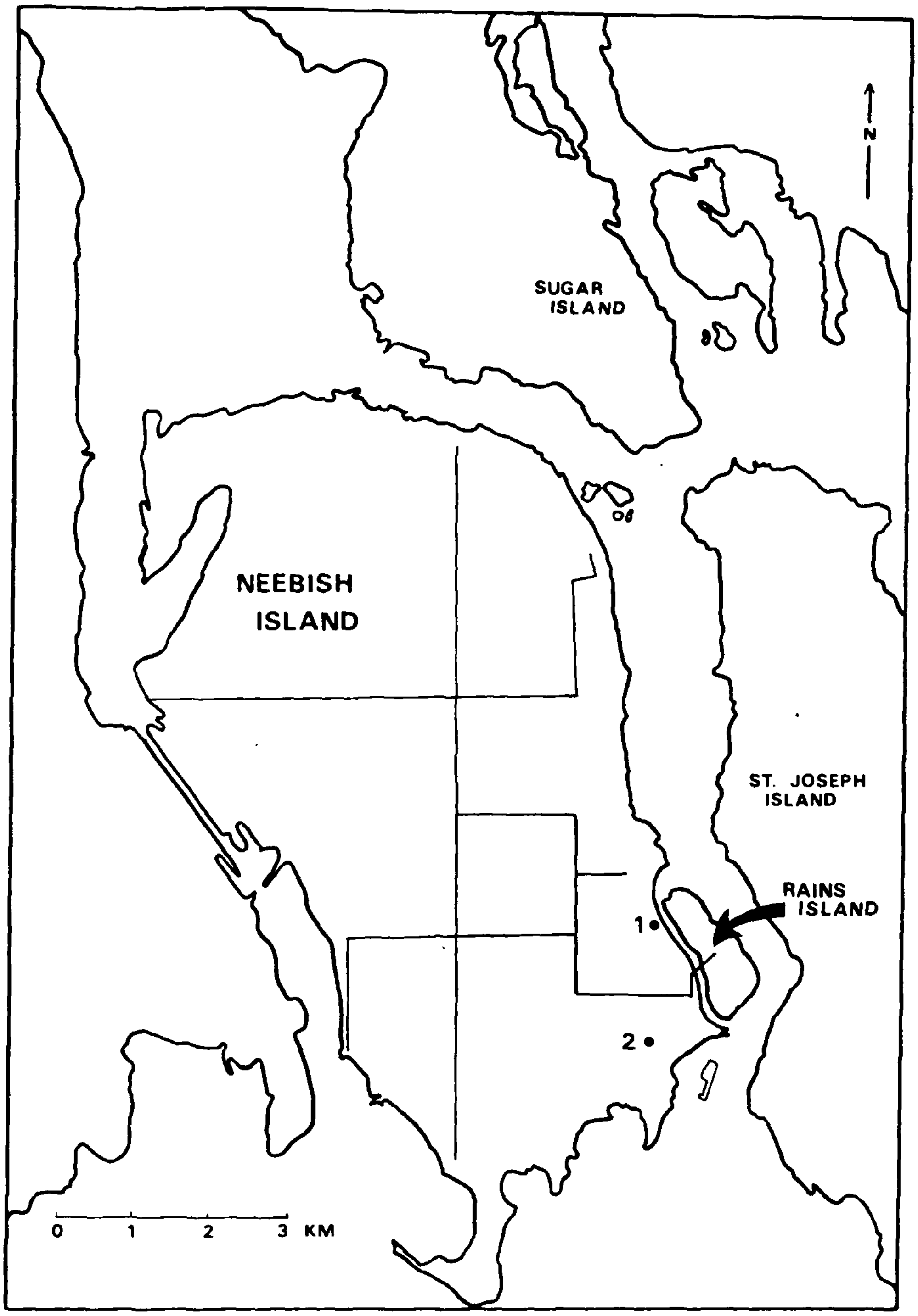

Figure 5. Locations of deer traps (numbers 1 and 2) on Neebish Island.

Radio tracking from the air became necessary when the radio-collared deer moved out of the winter yard or out of the range of receivers on the ground. Two antennas were mounted on the Piper PA-12 aircraft, one on each wing strut, with the researcher inside operating the receiver. Pin-pointing an animal involved locating the signal and circling the area within which the signal originated. The location error for aerial tracking was measured at 0.02 to 1.87 hectares (Hoskinson 1976). With practice, locating radio-collared deer became routine.

Estimates of D er Numbers and Mortality

We originally planned to estimate deer numbers by mark-resighting methods (Overton 1971). Deer were to be marked with self-attaching collars placed as snares on runways (Verme 1962). Verme succeeded in marking hundreds of deer with this method. Fifty of these self-attaching collars were set up in the deer yard on Neebish Island. The collars were anchored by wire to a tree and when a deer passed through, the collar would snap into place on the deer's neck and then break away from the anchoring wire. The collars were made of colored nylon rope and each had a colored, numbered cattle tag so individuals could be distinguished from one another. Probably because of shallow snow, deer avoided the collars, and only one animal was tagged by a self-attaching collar. Deer numbers were estimated by observation of deer feeding in fields on Southern Neebish Island. The estimate took into account the percentage of open fields visible from roadsides and the number of marked (radio-tagged) deer observed during sample periods.

Assessment of winter mortality was accomplished by a systematic dead deer search through selected transects on Southern Neebish Island 11 April (Figure 6). The search involved 20 volunteers, divided into three groups, with searchers walking parallel and spaced one chain (21.1 m) apart. The effectiveness of this method was shown in studies of deer in Beaver Basin, Michigan. In that study in 1979-80 all 24 deer carcasses known to be present by previous encounters were found by systematic search (Robinson et al. unpublished).

When a deer carcass was encountered the following data was collected: location of carcass; estimated time of death (year and season); and where possible, a determination of sex, age and probable cause of death. As available marrow permitted, three marrow samples were taken from each bone and analyzed using the dry reagent method described by Kie (1978). The percent of bone marrow fat (BMF) was used as an index of the individual's physical condition at the time of death, with below 30% considered poor.

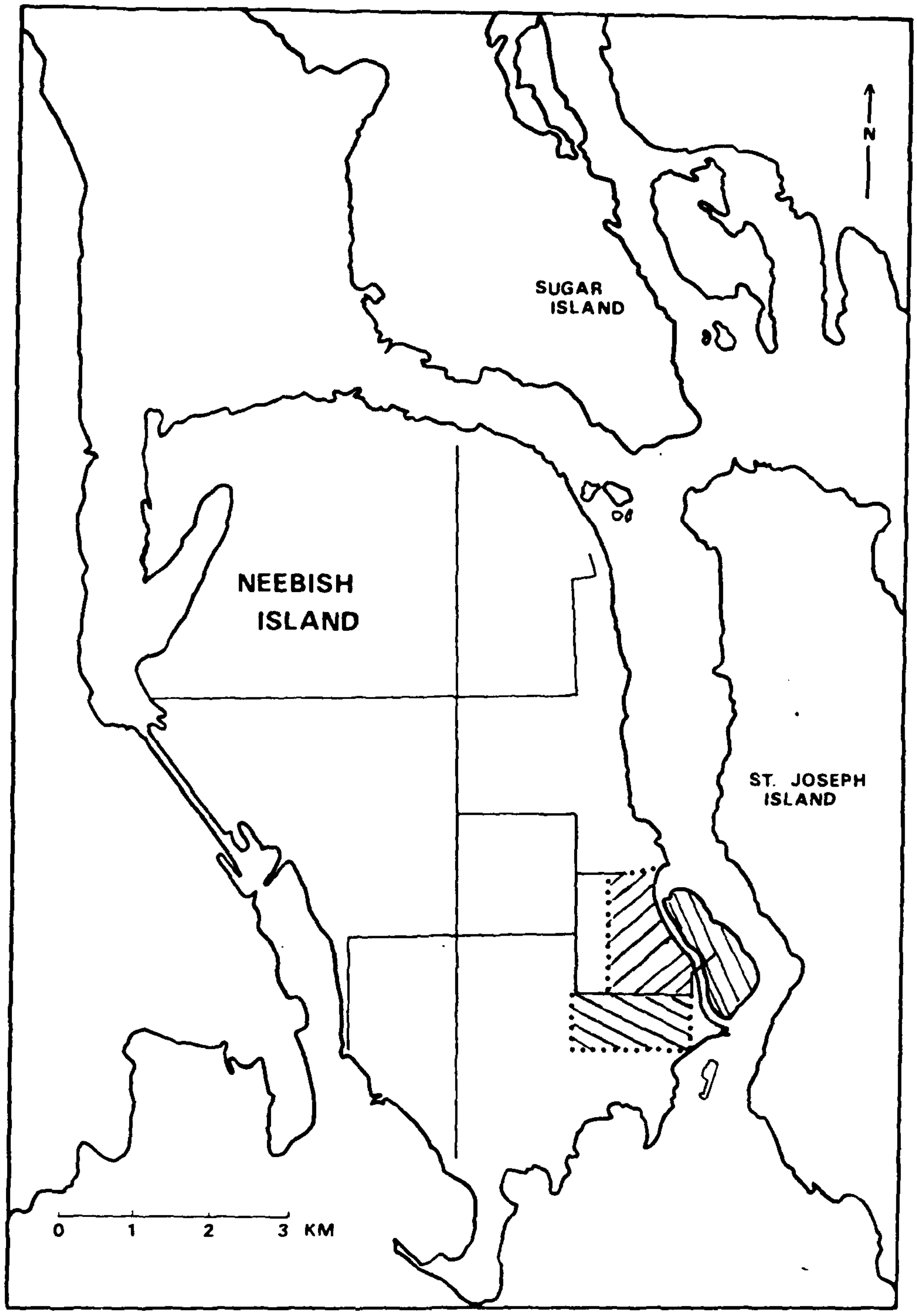

Figure 6. Transects surveyed during systematic dead deer search.

Browse Survey

The methods used by Beals et al. (1960) on the Apostle Islands were used as a guideline for browse analysis. These methods are summarized in the following paragraphs.

Browse condition and availability was estimated at two locations in the winter deer yard on southern Neebish Island, one location on Rains Island, and at one location on St. Joseph Island (Figure 7). The site sampled on St. Joseph Island was a 64 hectare cedar-fir stand that most deer crossing the Munuscong Channel entered into and exited from during the study period. The stands were selected to give a representative sample of the forests in the deer yards.

Sampling of trees and browse was done by the point-quarter method (Cottam and Curtis 1956), and data was taken at 20 random points along compass lines. Browse was considered as any woody stem with leaves and/or buds between the heights of 15 cm above average snow depth (38 cm) and the established browse line (approximately 2 m). Each sampled browse stem was classified subjectively into one of five categories of browse damage: no browsing, light browsing, moderate browsing, heavy browsing, and completely browsed. Browse data from each of the four locations were described in several ways: the relative density (number of stems of a species divided by the total number of stems of all species X 100), the relative number of stems in each browse category, and the minimum density of browse stems per hectare were obtained. The minimum density was calculated by averaging the distances obtained by the point-quarter method, squaring the average, and dividing into the number of square meters in a hectare, as described by Cottam and Curtis (1956).

Three numerical indices, browse condition index, preference rating, and pressure index, were described by Beals et al. (1960) to describe deer-vegetation relationships. The browse conditions index, describing the degree of browse damage for each stand, was calculated by multiplying the relative density of browse in each browse damage category by 0, 1, 2, 3, or 4: percentage browse undamaged by 0, slightly browsed by 1, moderately browsed by 2, heavily browsed by 3, and totally browsed by 4. These products were summed and divided by 100 giving a number between 0 and 4. A value of 4 indicates all stems sampled were totally browsed while a value of 0 indicates no stems were browsed. Since the browse condition index does not take into consideration the quality of browse available (deer are more likely to do damage to stands of choice food than stands of poore food), a preference rating was calculated. The species of plants present were divided into four categories (Table 4) as described by Dahlberg and Guettinger (1956). The preference rating was calculated by multiplying the relative density of the first choice food by 1, the second by 2, third by 3, and fourth by 4. These products were summed and divided by 100 giving a number between 1 and 4 for each stand. A value of 1 would indicate a stand of all first choice food and 4 a stand of fourth choice, or starvation food.

The browse condition index and the preference ratings are arrived at independently, and in order to describe each stand on the basis of browse damage and quality, the condition index and preference rating are multiplied together giving the pressure index. Possible results range from 0 to 16, 0 for any stand that has not been browsed regardless of the preference rating. The maximum 16 would describe a stand containing all fourth choice food, totally browsed. A value near 16 could not be reached under natural conditions as deer would die of starvation before all fourth choice food is totally browsed. The maximum value obtained in the Apostle Islands study of Beals et al. (1960) was 6.4. This was regarded as a very heavily browsed yard. Pressure indices of 6.01 and above indicated very heavily browsed stands, 4.01-6.00 heavily browsed, 2.01-4.00 moderately, .01-2.00 lightly, and 0 indicated no browse pressure (Beals et al. 1960).

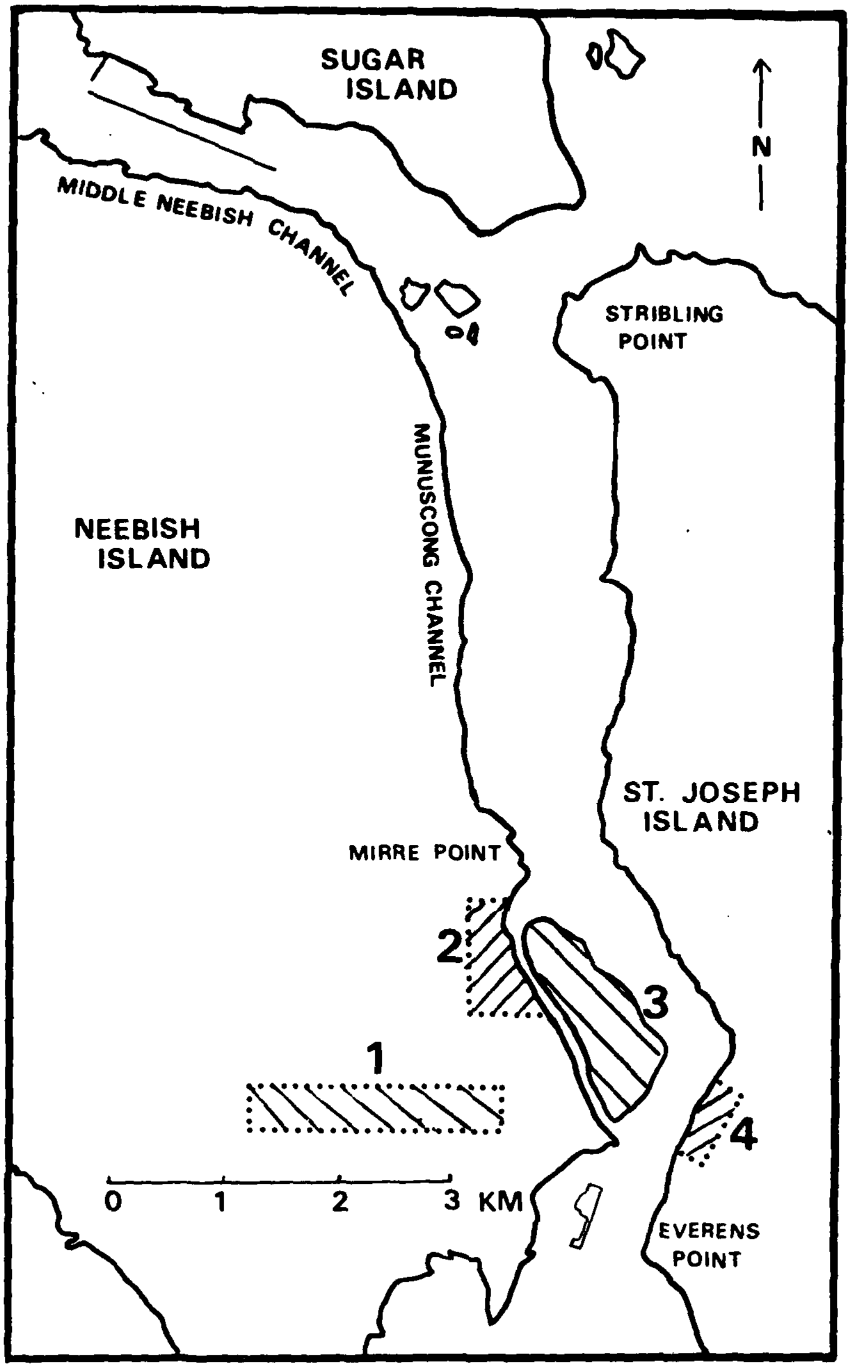

Figure 7. Browse survey transects. Transect no.1, Tally-Ho swamp; no. 2, southeast Neebish Island; no.3, Rains Island; and no. 4, St. Joseph Island.

Table 4. Preference Ratings of Browse Species Found in the St. Mary's River Study Area. Choices are According to Dahlberg and Guettinger (1956).

1st Choice

White Cedar (*Thuja occidentalis*)
Red Maple (*Acer rubrum*)

2nd Choice

Mountain Maple (*Acer spicatum*)
Yellow Birch (*Betula lutea*)
Fly honeysuckle (*Lonicera canadensis*)
Red-osier Dogwood (*Cornus stolonifera*)
Serviceberry (*Amelanchier spp.*)
Striped Maple (*Acer pensylvanicum*

3rd Choice

Balsam Fir (*Abies balsamea*)
Sugar Maple (*Acer saccharum*)
Red Oak (*Quercus rubra*)
White Spruce (*Picea glauca*)
Quaking Aspen (*Populus tremuloides*)
Michigan holly (*Ilex verticillata*)
Balsam poplar (*Populus balsamifera*)
Black ash (*Fraxinus nigra*)
Beaked hazel (*Corylus rostrata*)

4th Choice

Alder (*Alnus rugosa*)
Gooseberry (*Ribes spp.*)

PART IV: Results

Distribution of Mammals in the Study Area

Medium-sized and small mammals such as snowshoe hares (*Lepus americanus*) red squirrels (*Tamiasciurus hudsonicus*), and various mice are common throughout the study area. Foxes and coyotes are likewise common. Lynx are rare on the U.S. side of the border and uncommon on the Canadian side, and bobcats are common on the U.S. side and uncommon on the Canadian side (Robinson and Fuller 1980).

During the past winter, 1980-1981, information was gathered beyond that obtained in 1979-80 on the distribution of deer, moose, and wolves. Deer populations were extremely low along the Canadian shoreline of Whitefish Bay with a small yard present near Walls Lake (Figure 8). Cursory observations suggest a total population of less than 100 animals. Yarding areas for deer along the St. Mary's River included southeastern St. Joseph Island, Echo Lake, Desbarats Lake and Red Rock Lake, Ontario; southern Sugar, Neebish and Drummond Islands, Gogomain Swamp, and the Lake Huron shoreline near De Tour, Michigan.

Moose populations were low throughout the study area, but pockets of moose activity were located on Batchawana Island, Sand Bay, Squirrel Island, and St. Joseph Island. The Sault Ste. Marie office of OMNR reported small pockets of activity near the Goulais River, along Highway 17 near Laird, Corbeil Point and southwest of Havilland (Figure 9).

Based on cursory observations, the Sand Bay area and Batchawana Island are occupied by three and five moose, respectively. The OMNR estimates the St. Joseph Island herd at 12 to 15 individuals, and the Squirrel Island moose numbers at one or two. Michigan DNR and local sportsmen reported that two moose were present near Sheephead Lake (near Whitefish Point) and approximately four moose occupied an area east of De Tour.

We estimate the total population of moose within 25 km of the Whitefish Bay and St. Mary's River shoreline at about 35 in Canada and six in the United States.

From the information gathered by interviewing trappers and others, a map of recent timber wolf activity was developed (Figure 10). The areas shaded in Figure10 are those areas which are presumed to have been permanently inhabited by timber wolves between September 1980 and March 1981. Because this map is based on interviews with persons with varying degrees of experience with timber wolves, our confidence in pack sizes and location varies. For this reason each assumed timber wolf territory is denoted as being of high reliability (HR) or low reliabiltiy (LR).

Reliability was based upon apparent experience of the person reporting the wolves and upon whether or not more than one person

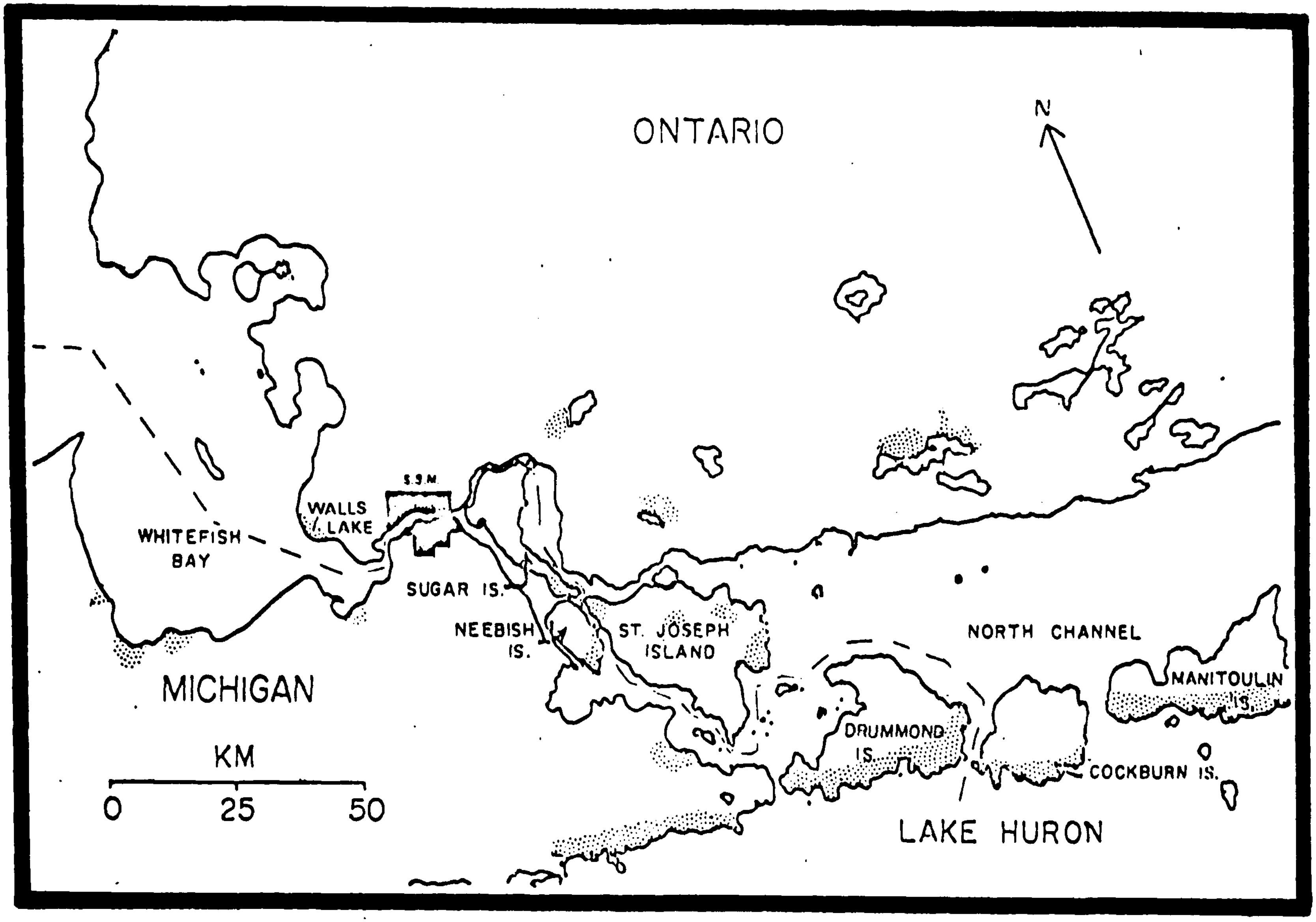

Figure 8 . Map showing locations of deeryards (shaded) in the study area.

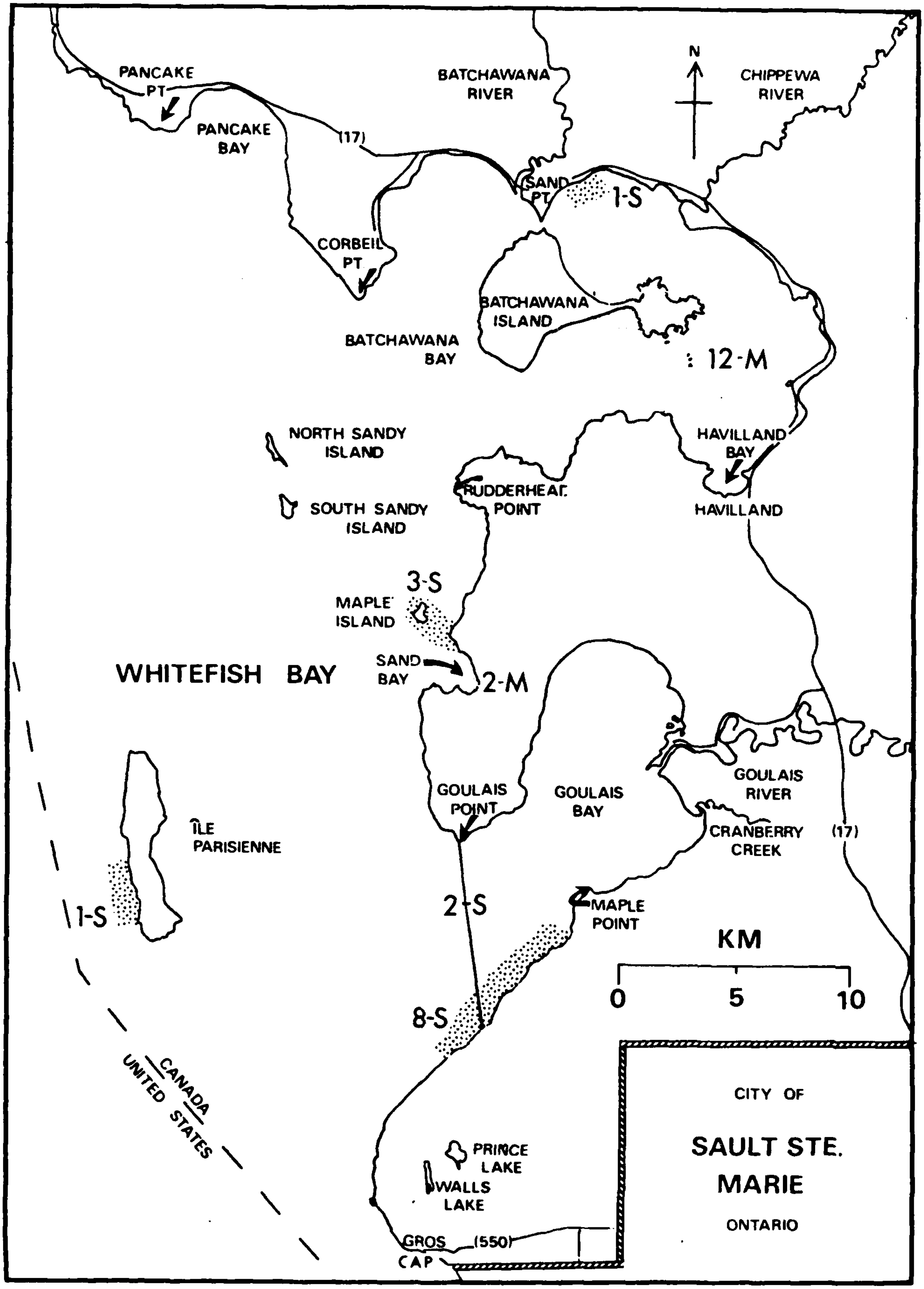

Figure 9. Locations and number of track observations of moose and snowshoe hare on the Canadian shore of Whitefish Bay (The symbol 2-M represents two moose track observations.

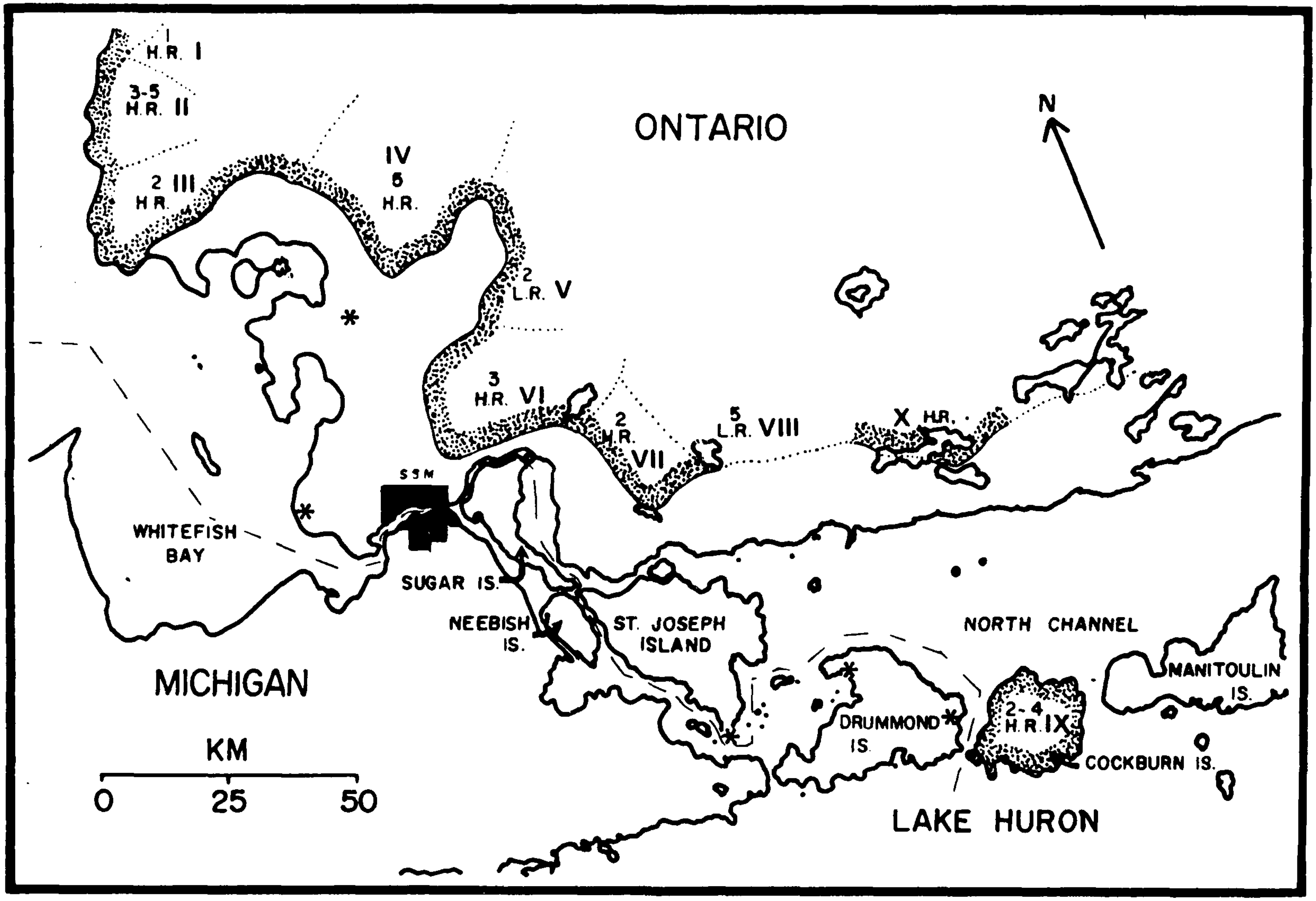

Figure 10 Map of timber wolf territories in the Whitefish Bay-St. Mary's River area, based upon interviews with trappers and biologists and upon track observations. Roman numerals designate the number of the pack and Arabic numerals indicate estimated number of wolves in the pack.

reported similar numbers and locations of wolves. An attempt was made to determine the number and size of packs within the study area. The boundaries of the individual pack territories were developed from the information which trappers provided (Appendix B) and estimates based on known timber wolf densities from comparable habitats (Mech 1966, Jordan et al. 1967, Pimlott et al. 1969, Van Ballenberghe et al. 1975).

Based on reports and direct observations, the home range of at least 18 timber wolves come within 25 km of the Whitefish Bay and St. Mary's River shoreline. A summary of pack size, territory size, and wolves per km^2 is given in Table 5. Locations of timber wolf tracks found and confirmed by researchers during the winter of 1981 are designated by a star on Figure 10.

Mammal Movements on the Ice

The St. Mary's River

During this winter 123 individual sets of mammal tracks were recorded crossing the river. Except for three deer that crossed East Neebish Channel, all crossings were made across Middle Neebish and Munuscong Channels (Figure 11 through 13). One hundred (78%) of the 124 tracks were of white-tailed deer, 10 (8%) were of coyotes, 8 (7%) were of dogs, 4 (3%) were of unknown canids, and one (1%) was of a fox. In addition, 12 sets of tracks were recorded (11 deer and one canid) in which animals did not cross the ship track but returned to shore. Many animal crossings were probably not recorded because of poor tracking conditions during most of February and March.

Robinson and Fuller (1980) pointed out that the actual number of tracks counted represents a minimum number of tracks; tracks of animals which walked on snowless ice or shortly before or during a snowfall were not observed. The compensation method described by Robinson and Fuller (1980) considers the number of tracks per day after a snowfall as a measure of the rate of activity. The time between the last track-obliterating wind or snowfall and the survey time is noted, and the number of tracks observed could thus be calculated as tracks/24 hours, or tracks/day. To make samples of different lengths of shoreline comparable, the length of shoreline of each sample also is used as a denominator, resulting in the number of tracks/km-day as a standard unit to compare activity rates between months of the winter and portions of the study area.

Table 6 summarizes crossing rates of various mammals on the St. Mary's River. Deer crossing rates were lowest in late January (2.80 crossings/km-day), higher in early February (3.15 crossings/km-day), and peaked in late February (3.25 crossings/km-day). Crossing rates declined during 1-10 March, with 2.09 crossings/km-day, and after 10 March there were no crossings.

Table 7 compares crossing rates by deer on the St. Mary's River in 1980 and 1981. Crossings of Middle and East Neebish Channels occurred only in January. All five deer that crossed Middle Neebish Channel traveled from Sugar Island to Neebish Island.

Table 5. Summary of the estimated number of packs, number of individuals and the territory size for wolves adjacent to Whitefish Bay and the St. Mary's River during the winter of 1981.

Pack	Estimated No. Individuals	Territory Size (km^2)	km^2 per wolf
I	1	70	70
II	3-5	148	29.6-49.3
III	2	305	152
IV	5	462	92
V	2*	210	105
VI	3	321	107
VII	2	175	88
VIII	5*	186	37
IX	2-4	173	43-86
Total or Mean	18-25	2050	82-114

*Denotes Low Reliability of pack size estimate.

Table 6. Mean Number of Crossings/km-day by Mammals on the St. Mary's River, 13 January to 23 March 1981. Total Number of Crossings is Shown in Parentheses.

Period	Number of km-days	SPECIES				
		Deer	Coyotes	Dogs	Unknown Canids	Red Fox
January (13-31)	16.4	2.80 (46)	0.24 (4)	0.0 (0)	0.24 (4)	0.0 (0)
February (1-28)	9.4	3.19 (30)	0.64 (6)	0.0 (0)	0.0 (0)	0.11 (1)
March (1-23)	13.9	1.73 (24)	0.0 (0)	0.58 (8)	0.0 (0)	0.0 (0)
TOTALS	39.7	2.52 (100)	0.25 (10)	0.20 (8)	0.10 (4)	0.03 (1)

Table 7. Comparison of the Mean Number of Crossings/km-day (X 10) by Deer on the St. Mary's River, 15 January - 22 March 1980 and 1981. Number of km-days for Which Tracks Were Recorded in Each Period is in Parentheses.

	Total Number of Crossings	January 15-31	February 1-13	February 16-29	March 2-15	March 17-22
1980	281	1.00 (95.3)	.93 (532.9)	.49 (271.7)	.78 (440.8)	1.82 (42.7)
1981	100	28.0 (16.4)	31.5 (5.4)	32.5 (4.0)	20.9 (11.5)	0 (2.4)

Table 8 summarizes deer crossing rates for various channels of the St. Mary's River, for 1980 and 1981. On Munuscong Channel between Mirre and Johnson Points, 19 crossings were observed in January. There were no crossings in February or March between Johnson and Stribling Points (northern Munuscong Channel), but crossing activity was highest in February (8 tracks/km-day) between Johnson and Everens Points.

Only 10 coyote crossings were noted, four in January and six in February. Five animals crossed Middle Neebish Channel (four in February, one in January) and five crossed Munuscong Channel (three in January, two in February).

All eight dog crossings were seen on 10 March between St. Joseph and Rains Island, north of Johnson Point. It is probable that all eight tracks were made by two dogs which were reported by island residents to have killed a buck fawn on 9 March. Four unknown canid (dog, fox or coyote) tracks were observed in late January (three on 24 January, one on 26 January) along the Munuscong Channel. One fox crossing was noted on 27 February, traveling from Neebish to St. Joseph Island.

The five deer crossing Middle Neebish Channel traveled southwest from Sugar Island to Neebish Island. Of the 92 deer crossings observed on the Munuscong Channel during the study period, 40 (43.5%) crossed west from St. Joseph to Neebish or Rains Island, and 52 (56.5%) crossed east from Neebish or Rains Island to St. Joseph Island. A chi-square test to determine whether the direction of the 92 crossings was significantly different from random movement indicated that movement was not significantly different from random ($Chi^2 = 1.56$, $p > .30$). This suggests that there was no significant tendency to cross Munuscong Channel in one direction. During the period from 1 March to 10 March, 18 deer crossed east to St. Joseph Island and six crossed west to Neebish Island. A chi-square test ($Chi^2 = 6.0$, $p < .05$) indicated crossings were not random. The test suggested that deer were moving from Rains Island to St. Joseph Island.

During the study period, crossings of the lower Munuscong Channel between Johnson Point and the southern point of Rains Island were frequent. Seventy-four (80%) of the 92 crossings of Munuscong Channel occurred in this area of the channel. As noted previously from 13 January to 23 March there was no significant tendency to cross in either direction. Based on this information and because at no time during track survey periods were there more than ten sets of deer tracks heading in one direction, we estimated that about 12 animals habitually crossed this portion of the channel.

Because crossing rates were not constant throughout the entire winter, the same correction methods used in 1980 to estimate the number of crossings were used again in 1981 (Robinson and Fuller 1980). Crossing rates were assumed to be one-half of observed rates for days in which at least two or three weather variables were considered a hindrance to the observation of mammal tracks and probably to animal movement (daily snowfall>2 cm, mean wind speed>12 km/hr. and >50% cloud cover). These conditions occurred 63% of the days when tracks were not being recorded.

Table 8. Comparison of Mean Number of Crossings/km-day (X 10) of Deer on Various Segments of the St. Mary's River, 15 January - 22 March 1980 and 1981. Total Number of km-days for Each Segment is Shown in Parentheses.

Channel Segment (shipping channels only)	1980	1981
Middle Neebish Channel	3.66 (106.6)	4.49 (11.14)
North Munuscong Channel (North of Mirre Point)	0.77 (90.8)	0.00 (0)
Munuscong Channel (South of Mirre Point)	20.04 (104.8)	32.21 (28.56)

Using this correction factor, total crossings of the shipping channel were estimated at 508; including 441 (86.8%) by deer, 32 (6.3%) by coyotes, 24 (4.7%) by dogs, 8 (1.6%) by unknown canids and 4 (0.8%) by red foxes. Table 9 compares estimated corssings for each species in 1980 and 1981.

Whitefish Bay

During the period of 11 January to 26 March, 175 individual sets of tracks were located on the ice of Whitefish Bay. Figures 9, 11, and 12 indicate the locations of all tracks observed during aerial and ground surveys of Whitefish Bay. One hundred forty-seven (84%) of the tracks were of coyote, red fox, and unknown canids. Fourteen tracks (8%) were those of moose, and fourteen tracks (8%) were identified as snowshoe hare. There were also one red squirrel and one weasel track. No bobcat, lynx, or wolf were observed (Table 10). Of the 147 coyote, red fox and unknown canid tracks located, 31 (21%) were more than one km from shore. Other animals may have traveled this distance from shore, but their tracks were not detected due to wind and snow obscuring them. Also the survey technique involved flying 150 to 250 m out from the shoreline, thus preventing coverage of areas in excess of 500 m from shore.

Table 11 summarizes the locations of tracks on the Whitefish Bay shoreline. Fifty-two percent were in the vicinity of Maple Point and along the Goulais Peninsula between Goulais Point and Rudderhead Point. Another area of concentrated activity was Batchawana Island. The preponderence of the tracks recorded were of coyotes and unknown canids. No deer tracks were found on Whitefish Bay.

Tracks of canids were located in every section of shoreline surveyed, with the majority of the tracks along the western edge of the Goulais Peninsula (40 tracks: 27%), the area adjacent to Maple Point (33 tracks: 22%) and the eastern one half of Batchawana Island (Figures 11 and 12). These high track densities are believed to be in response to fish left on the ice by commercial fishermen. Coyotes would visit gill net sites to scavenge fish remains. In March, the only other area where tracks were found was North and South Sandy Island (six tracks), Ile Parisienne (four tracks), and Grass Bay west of Havilland (four tracks). At least four coyotes were believed to have crossed the 5.7 km to Ile Parisienne (Figure 11). The only red fox track positively identified was located near South Sandy Island on 4 February (Figure 12).

Moose tracks on the ice were noted only in two areas. Two of the 14 sets of tracks were found along the shore of Sand Bay; the remainder of the tracks were located along the shoreline of the east and southern portions of Batchawana Islands (Figure 8). Short forays by moose to the small island near the eastern shoreline of Batchawana Island were observed during early February. The misleadingly high track rates noted for moose in the Sand Bay area is based on two tracks in a 4 km section surveyed 0.5 days after a snowfall (Table 12).

Of the 14 snowshoe hare tracks observed, 13 were located on the ice of Goulais Bay and around the perimeter of Maple Island (Figure 9).

Table 9. Comparison of Estimated Total Number of Crossings by Mammals of the Shipping Channel on the St. Mary's River, 13 January to 23 March 1980 and 1981. Percent of Column Total is Shown in Parentheses.

Species	1980		1981	
Deer	598	(66.2)	441	(86.8)
Coyote	155	(17.2)	32	(6.3)
Dog	40	(4.4)	23	(4.7)
Canid	55	(6.1)	8	(1.6)
Red Fox	55	(6.1)	4	(0.8)
TOTAL	903		508	

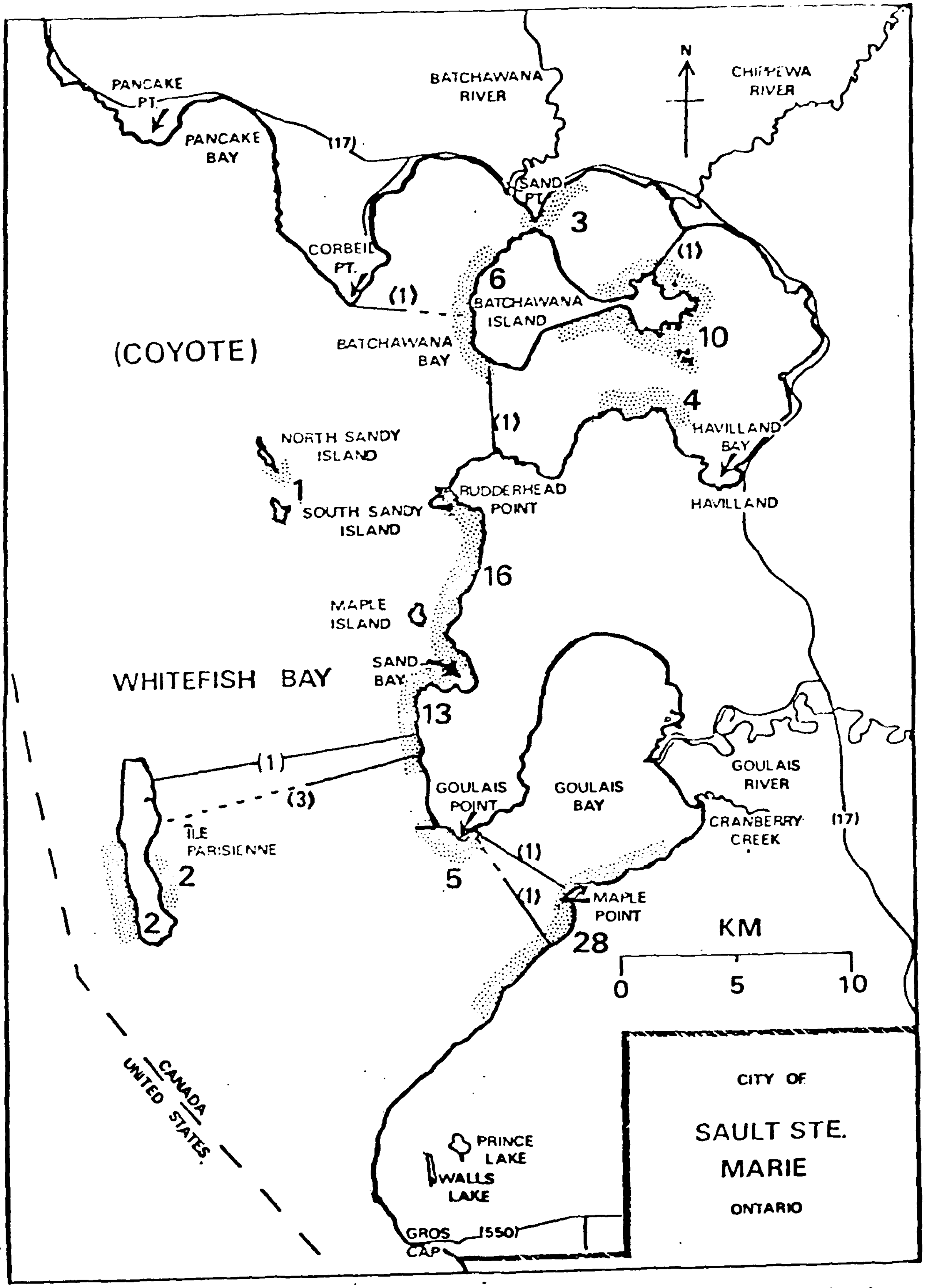

Figure 11. Location (shaded areas) and number of coyote tracks on the ice of Whitefish Bay. Lines denote crossings, and the number involved is given in parentheses.

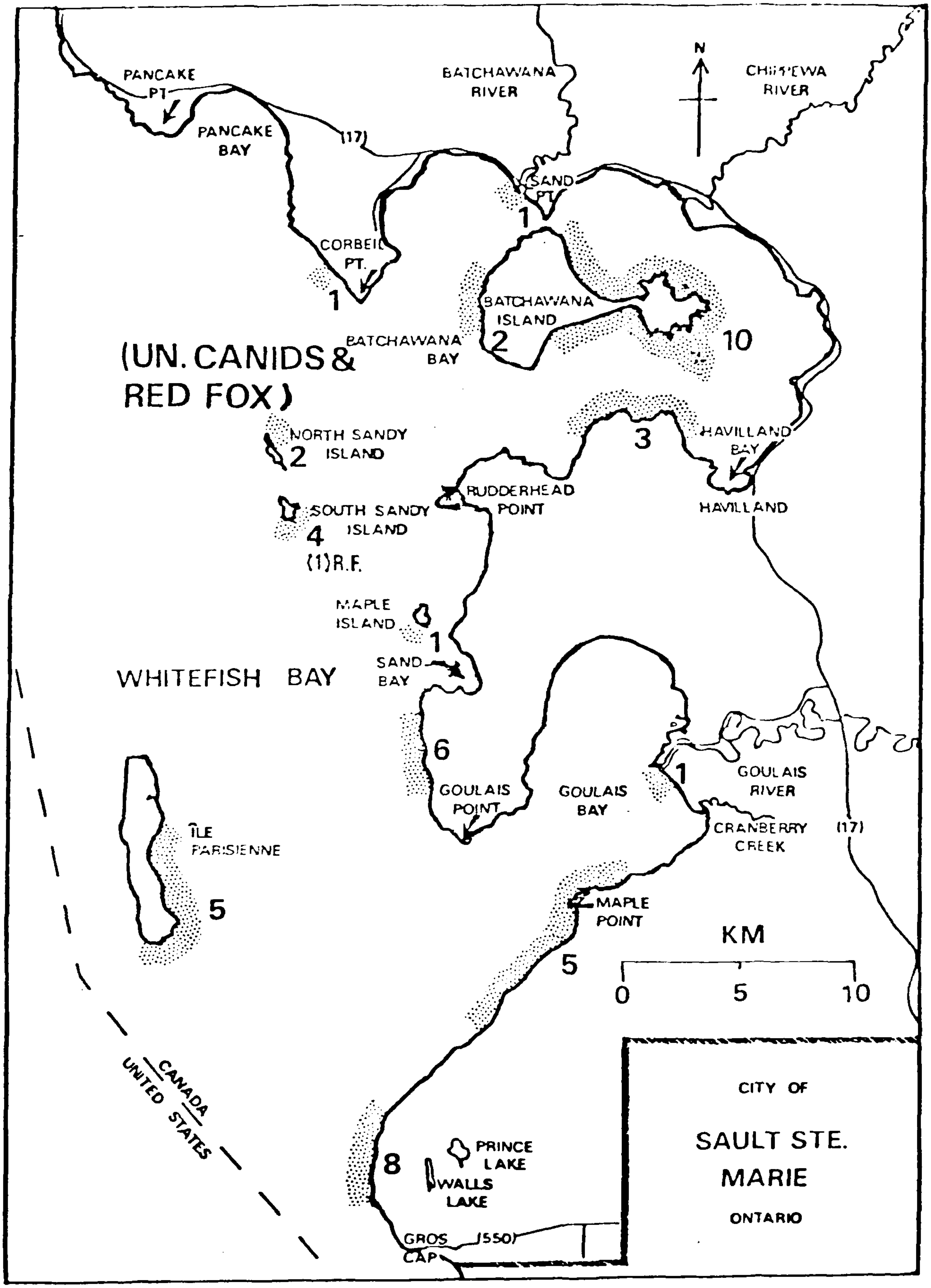

Figure 12. Location and number of unknown canid and one red fox tracks on the ice of Whitefish Bay (shaded areas). Fox track is indicated by R.F.

Table 10. Summary of Data Collected on Maximum Observed Distance Traveled From Shore by Coyotes, Unknown Canids, Red Fox, Moose, Snowshoe Hare, Weasel, and Red Squirrels on the Ice of Whitefish Bay, and Timber Wolf Tracks Found on the Ice of the St. Mary's River, 11 January to 26 March 1981.

Species	No. of Tracks	Maximum Distance From Shore (km)	Mean Maximum (± 95% C.L.) Distance From Shore (km)	S.E.	S.D.
Timber Wolf	3	1.8	1.21	1.16	2.00
Coyote	96	5.7	0.67	0.22	2.12
Unknown Canids	50	--	.11	.05	.35
Red Fox	1	3.8	3.8	--	--
Moose	14	0.35	0.21	.07	.27
Snowshoe Hare	14	4.0	1.26	.84	3.15
Weasel	1	3.0	3.00	--	--
Red Squirrel	1	0.02	0.02	--	--

Table 11. Summary of the Geographic Location of Tracks/km-day Recorded for Various Species of Mammals on the Ice of Whitefish Bay Between 11 January and 26 March 1981. Number of km-days for Which Tracks Were Recorded for Each Segment of Shoreline are in Parentheses.

Shoreline[a] Segment	Segment Length (km)	Coyote	Unknown Canid	Moose	Snowshoe Hare	Total
Gros Cap to Maple Pt. (110)	18.5	9.73	0.24		3.30	13.27
Maple Pt. to Goulais River (63)	10.0	0.40	0.16		0.33	0.89
Goulais River to Sand Bay (111)	9.0	0.83	0.18		0.09	1.10
Sand Bay to Rudderhead Pt. (42)	8.0	4.55		1.0		5.55
Rudderhead Pt. to Havilland (130)	12.5	0.37	0.15			0.52
Sand Pt. to Batchawana Bay (38)	6.5	0.42	0.12		0.15	0.69
Batchawana Govt. Dock to Corbeil Pt. (14)	2.5	0.40				0.40
Maple Island (10)	2.0	0.38	0.12		1.05	1.55
Batchawana Is. (338)	29.0	0.37	0.3	0.24		0.92

Table 11. (continued).

Shoreline[a] segment	Segment length (km)	Coyote	Unknown canid	Moose	Snowshoe hare	Total
No. Sandy Is. (16)	3.5	0.21	0.12			0.33
So. Sandy Is. (11)	2.5	0.30	0.47			0.77
Ile Pariseinne (186)	16.0	0.18	0.22		0.07	0.47
Total Shoreline (1069)	120.0	18.14	2.09	1.24	4.99	26.46

[a]Shoreline segments are shown in Figure 2.

Considering all species, activity on Whitefish Bay was greatest in January, decreased to a low in February, and increased slightly in March until the ice broke up (Table 12). Eighty percent of the tracks recorded occurred in January and March.

Coyotes were most active on the ice in late January, with lower levels of activity during the rest of the winter (Table 12). High activity rates for this period are probably biased by two factors. Coyotes responded to commercial gill net fishing by scavenging for fish remains on the ice near net sites; and some large red fox tracks may have been misidentified as coyote. Regardless of these factors, we feel the overall pattern of high activity levels in late January reflects the actual behavior patterns of coyotes.

The temporal distribution of unknown canid tracks on the ice mimicked that of coyotes, with generally more activity in January and a decrease in February and March (Table 12). Due to the age of these tracks and, in a few instances, the close proximity to occupied human dwellings (raising the possibility of dogs), they were identified as unknown canids. Tracks placed in this category were most likely those of coyote or red fox. Therefore, the similarity of the activity patterns is understandable

Only one set of tracks was identified as being those of red fox (Table 12). No doubt, some of the tracks categorized as unknown canids were those of red fox. The low number of fox tracks on the ice is felt to be the result of low population levels rather than avoidance of ice travel by foxes.

Only 14 sets of moose tracks on the ice were found, making it difficult to describe seasonal trends in moose activity (Table 12). The relatively high rate recorded in January is based on a small sample size (two tracks found in 5 km, 0.5 days after a snowfall). Nine sets of tracks were located along the eastern shore of Batchawana Island in early February.

Hare activity on the ice peaked in January and declined dramatically in February and March (Table 12). The sample size is small, however, with the January estimate being based on nine sets of tracks and the February and March estimate based on three and two sets, respectively.

Due to weather conditions, the total number of mammals traveling on the ice of Whitefish Bay had to be estimated indirectly from the tracks observed. The number of coyotes, unknown canids, and moose traveling on the ice in each shoreline segment was estimated by multiplying the track rate for each species (tracks/km-day) by the length of the segment and the number of days in the particular month (Tables 11 and 12). For example, in January a 10 km segment had a track rate of 0.50 tracks/km-day. Thus, 0.50 multiplied by 10 equals an estimate of 5.0 tracks/day for this particular segment. By multiplying this product by the number of days in the month of January, we may estimate the number of track per segment per month. In this case, the estimate would be 155 tracks. This assumes that activity during sample periods was typical of activity through the rest of the month.

Table 12. Mean Number of Tracks in Excess of 10 m From Shore/km-day by Mammals on the Ice of Whitefish Bay, 11 January to 26 March 1981. Number of km-days for Which Tracks Were Recorded in Each Period is in Parentheses.

Species	January 11-31	February 1-28	March 1-26	Total No. of Tracks
	(200.1)	(79.2)	(103.1)	
Coyotes	5.72	0.04	0.15	96
Canids[a]	0.13	0.06	0.03	50
Red Fox	0.00	0.03	0.00	1
Moose	0.80	0.02	0.01	14
Snowshoe Hare	2.05	0.01	0.01	14
TOTAL	8.70	0.16	0.20	175[b]

[a]Unknown canids, probably those of coyotes or red fox.

[b]Does not include one short tailed weasel and one red squirrel track.

We used this procedure to estimate the total number of mammals traveling on the ice of the Whitefish Bay study area, by species, for each month (Table 13). Travel by coyotes was the most common (89.7%) of the estimated 6951 tracks on Whitefish Bay. The high January activity estimate for moose is the effect of a small sample size (two tracks observed in a 4 km segment, 0.5 days after a snowfall). The actual number of moose traveling on the ice is believed to be between 20 and 30 for the winter, based upon moose sign observed along the shore and the apparent reluctance of moose to travel very far on ice.

Because of the high susceptibility of tracks to obliteration on Whitefish Bay by snow and high winds, the percentage of animals that crossed the Bay could not be determined. For this reason, the mean maximum observed distance each species traveled from a shoreline was calculated to compare tendencies of different species to travel away from shore and to indicate likelihood of encountering a ship channel at a particular distance from shore. For example, Table 9 shows that coyotes, red foxes, and snowshoe hare tend to travel farther out onto the ice than moose and red squirrels. A ship channel located one km from shore would likely be encountered frequently by coyotes, with a mean maximum distance of 0.67 km and a standard deviation of 2.12 km, and rarely by moose with a mean maximum observed distance from shore of 0.21 km and a standard deviation of 0.27.

Type of Movement on Ice

Two basic types of movements on the ice were noted. The first, parallel travel along the shoreline, usually occurred close to the shore and frequently along the ridges of ice where snow was shallow and travel easy. The second type of movement consisted of travel perpendicular to the shore in a direction that would not intersect the shoreline in the immediate area of the animal's departure.

Of 96 sets of coyote tracks observed on the ice of Whitefish Bay, 57 (59.4%) were traveling parallel to the shoreline. The mean maximum distance from shore during parallel travel was 148 m (95% C.L. of S.D. $\pm$ 446 m). Of the 51 sets of coyote tracks observed during January and February, 37 (72.5%) were traveling parallel to shore. In March only 44.4% of the tracks were observed traveling parallel to shore (N=45).

To test the null hypothesis that there was no difference between the proportion of coyotes traveling perpendicular to the shore during March and those traveling perpendicular to shore in January and February on 2x2 chi-square contingency table was noted. The X^2 value of 7.83 yields a probability of < 0.01 that there is no difference. Coyotes are therefore more likely to travel perpendicular to shore in March than during January and February, suggesting that March may be a more important time for dispersal than early winter.

Sixty-six percent (33) of the 50 unknown canid (coyote, fox, or dog) tracks were traveling parallel to the shore of Whitefish Bay. The mean maximum distance of parallel travel from shore was 71 m ($\pm$ 155 m). Of the 42 sets of tracks observed during January and February only 11 (25%) were traveling perpendicular to the shore.

Table 13. Estimated Total Number of Mammal Tracks on the Ice of the Whitefish Bay Study Area in Excess of 10 Meters From Shore, 11 January to 26 March. Calculations Were Based Upon Assumption of Constant Activity Rates Within Each Month, and on the Temporal and Geographic Distributions Presented in Tables 11 and 12. Percent of the Column Total is in Parentheses.

Species	January	February	March	Total
Coyote	5541 (92.1)	134 (52.8)	558 (82.2)	6233 (89.7)
Unknown Canids	446 (7.4)	101 (939.8)	112 (16.5)	659 (9.5)
Red Fox	0	3 (1.1)	0	3 (0.1)
Moose	31 (0.5)	16 (6.3)	9 (1.3)	56 (0.8)
TOTALS	6018	254	679	6951

[a]Does not include red squirrel, snowshoe hare, and weasel tracks in the study area.

During March, six (75%) of the eight unknown canid tracks observed were traveling perpendicular to the shore. The same null hypothesis was used on the unknown canid data to test the significance of parallel versus perpendicular movement comparing January-February and March. The X^2 value of 7.134 yeilds a probability of < 0.01 that there is no difference. Therefore, the unknown canids, like identified coyotes, also were more likely to travel perpendicular to shore in March than in January and February.

Two of the 14 sets of moose tracks observed were traveling perpendicular to the shore. These were short excursions to small islands on the eastern end of Batchawana Island. Only one moose of the 14 whose tracks were observed appeared to have altered its course as a result of ice conditions. A calf which was believed to have been chased out on the ice of Sand Bay by poachers on 13 January, apparently was diverted when it slipped slightly on ice covered by less than 1 cm of snow. As a result the calf turned approximately 90^o and returned to shore.

No direct observations of the effects of ship passage on mammal movements were made on Whitefish Bay. All commercial shipping ceased on Lake Superior between 1 January and 24 March, 1981. Warm weather conditions and lack of snowfall after 24 March did not permit track observations.

On 17 January, 5 km south of Havilland, Ontario, a fresh wolf track was found crossing Highway 17. During a ground survey on 27 February in the Walls Lake deer yard, tracks (8 cm X 18 cm) and scats (2.5 cm in diameter) assumed to be those of timber wolf were found. The size of the tracks and squat-type urination suggested that the individual was a female. The route of this animal was followed for approximately 6.5 km and led to six carcasses of white-tailed deer. With the four carcasses previously found the total number of carcasses found in the yard was ten. This yard also has been known to be frequented by domestic dogs. This brings up the possibility that the tracks may have been those of a dog and/or that dogs may have killed the deer. However, because of the avoidance of human dwellings, the large diameter of the scats and the presence of deer hair in the scats (Weaver and Fritts, 1979) it is likely that the animal in question was a timber wolf.

On 6 March, Patrick Kelly of Drummond Island reported finding tracks of two timber wolves which he back-tracked by snowmobile to an area near St. Joseph Island. The tracks and snow conditions suggested that the wolves spent the night of 3 March on Harbor Island. A photo of one track is presented as Figure 13. We followed these tracks by airplane on 7 March across Drummond Island and across False De Tour Channel to Cockburn Island (Figure 14). Ground checks on 7 March also confirmed the point of departure from St. Joseph Island as Old Fort St. Joe Point at the southern tip of the island. By measuring at 1 km intervals the mean distance the wolves traveled from any shoreline was 0.7 km, with the maximum distance being 1.8 km.

Tracks of at least one timber wolf were located by air on the ice along the northwestern shoreline of Cockburn Island on 24 March. The maximum distance from shore was 30 m.

Figure 13. Photograph of track of timber wolf on Drummond Island, 6 March 1981.

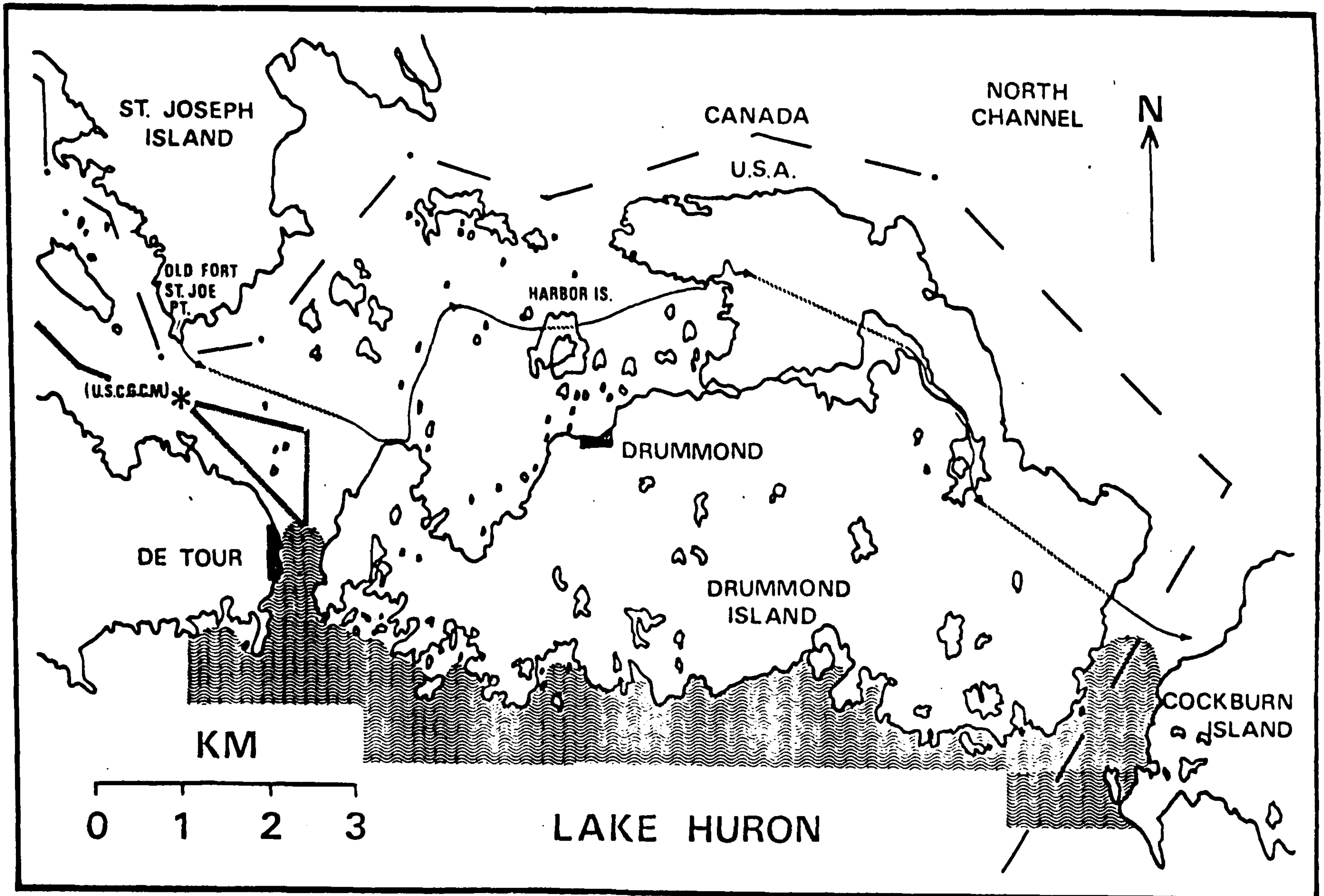

Figure 14. Map of tracks of two timber wolves crossing from St. Joseph to Drummond Islands. Solid arrows symbolize known movements. The shaded areas denote open water. An asterisk marks the position of the U.S. Coast Guard Cutter Mackinaw on 3 March 1981.

During a ground survey of Drummond Island on 27 March, a wolf scat (3 cm in diameter) was found on a jeep trail (T41N, R7E, Sec. 15, NE 1/4). The scat was composed entirely of deer hair. Because of its location and apparent age, this scat was probably deposited by one of the two wolves which visited the island on 4 and 5 March. Based on these few sightings, the movements of timber wolves on the ice was concentrated around Drummond and Cockburn Island, and involved at most three to four animals.

Deer Mortality in Whitefish Bay and Drummond Island Areas

A total of ten white-tailed deer carcasses were located in the Walls Lake deer yard during the 1981 winter (Figure 15). The cause of death of only one animal was determined. Blood spattered on the surrounding trees and the presence of coyote tracks suggested coyote predation. The mean percentage of bone marrow fat present in four of the deer was 91% (ranging from 81.3 to 96%), suggesting very good physical condition (Table 14).

The carcass of a 1-3/4 year old buck was found on Drummond Island (41N, R7E, Sec. 16) on 4 March. The cause of death was coyote predation during the previous night. Bone marrow fat content was determined to be 53.8%.

Deer in the St. Mary's River Area

On 11 March, 50 deer were seen on all fields visible from roads on southern Neebish Island. Using topographic maps which were photo-revised in 1976, we estimated that 60% of the fields, on southern Neebish Island are visible from the roads. Many deer were not out in the fields at the time, because some deer were also seen in the woods. None of the four known marked deer was seen in the fields. Under similar circumstances in Minnesota, Rongstad and Tester (1969) observed two of seven marked deer among 82 deer seen in fields, and estimated that about 25% of the deer present were visible. If we estimate that 25% of the deer on southern Neebish Island were visible in the fields and 50 deer were counted in 60% of the fields an estimate of 333 deer is obtained. It seems that 300-500 deer is a reasonable estimate of deer numbers on southern Neebish Island in March.

The systematic dead deer search conducted 11 April, covered 348 hectares (27.2%) of the estimated 1,282 hectares making up the winter deer yard on southern Neebish and Rains Islands. Twenty-five carcasses or parts of animals were found during the search. Ten of these deer were determined to have died in the winter of 1980-81. In addition, two other dead deer were found during the study period. On 8 February viscera from a poached deer were found in a plastic bag on southern Neebish Island. On 6 March, a buck fawn was killed by dogs near the shore of northern Rains Island on the Munuscong Channel. Bone marrow from this animal was examined and found to be very red and gelatinous indicating the animal was in poor nutritional condition (Cheatum and Severinghaus 1956). Of the 12 animals, two were killed by dogs, two were poached and eight died of undetermined causes. Table 15 summarizes data collected for deer that

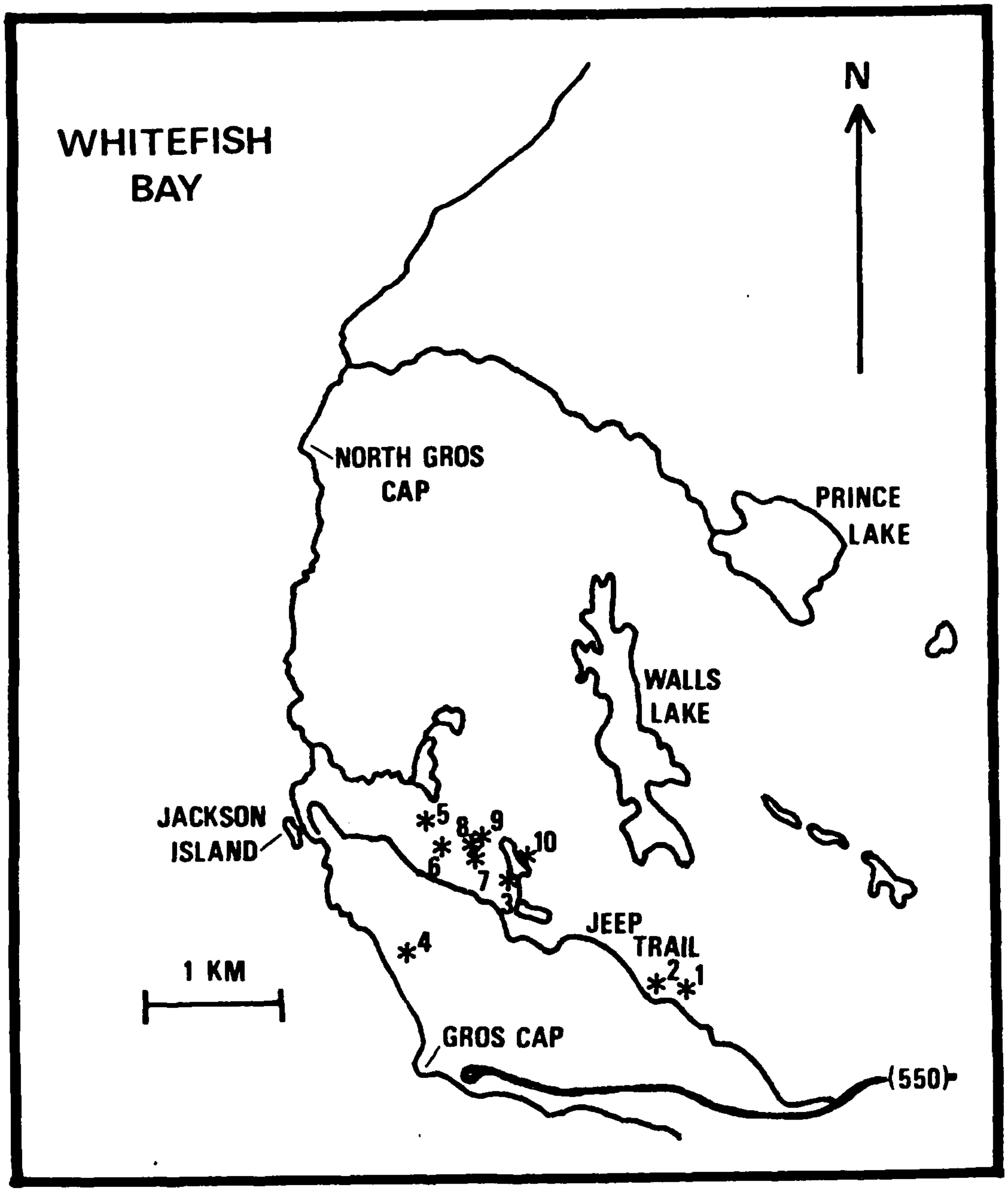

Figure 15. Location of deer carcasses found 28 January and 2 February 1981, in the Walls Lake, Ontario, deeryard.

Table 14. Summary of Deer Mortality on Neebish Island, Winter 1981.

Carcass Number	Estimated Date of Death	Sex	Age	Cause of Death	% Bone Marrow Fat
1	March 1981	Female	Fawn	Possible malnutrition	31
2	Unknown[1]	Unknown	Unknown	Unknown	--
3	Unknown	Female	2-3 yrs.	Unknown	--
4	Unknown	Unknown	Fawn	Unknown	--
5	Unknown	Unknown	Unknown	Unknown	--
6	17 March, 1981	Male	Fawn	Dogs	65
7	Unknown	Unknown	Fawn	Unknown	--
8	Unknown	Male	Adult	Poached	--
9	Unknown	Unknown	Fawn	Unknown	--
10	Unknown	Unknown	Adult	Unknown	--
11	Jan-Feb, 1981	Unknown	Adult	Poached	<20 [2]
12	9 March, 1981	Male	Fawn	Dogs	<20 [2]

[1]Unknown date of death means at some time during the winter of 1980-81.

[2]By visual inspection, probably less than 20 percent marrow fat.

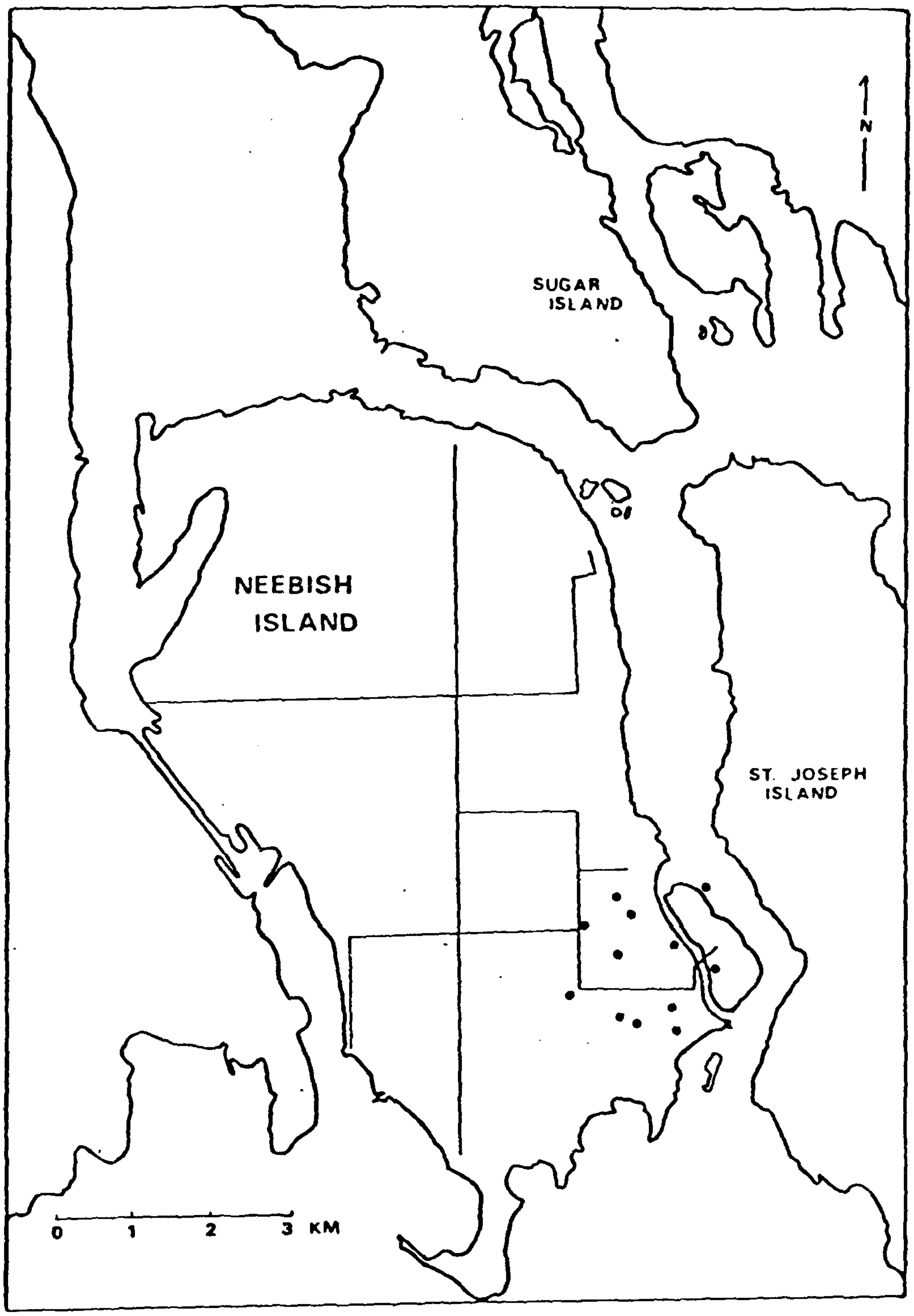

Figure 16. Locations of deer mortality in the Neebish Island deeryard during the winter 1980-1981.

died in the winter of 1980-81 on Neebish Island and Figure 16 shows where these deer were found. Bone marrow samples were taken and chemically analyzed for fat content for one male and one female fawn, and visual inspection of marrow was done for the buck fawn found 6 March. Analysis of marrow fat from these three fawns indicated a wide range of nutritional conditions existed among the deer

The systematic dead deer search covered 27% of the winter yard and ten carcasses from 1981 were found. Using this information, we estimated approximately 37 dead deer in the entire winter yard. This estimate assumes that all dead animals in the transects surveyed were found. We feel confident that nearly all of the dead deer in each transect were found. Two carcasses, found before the organized search, were located again during the search; searching conditions were ideal, with only patches of snow remaining on the ground, so carcasses were not buried; and 15 carcasses (parts of skeletons) of deer that died in previous years were found during the search. With a population estimate of 300-500 deer in the winter yard on southern Neebish Island, 37 dead deer would be a mortality rate of 7-12% of the deer present. Winter mortality below 15% of total population can be regarded as moderately low. In the Petrel Grade year near Shingleton, Michigan, mortality of 5-10% is regarded as low (Verme, personal communication).

Five deer were trapped and fitted with radio-transmitters in February and March, 1981. Figures 17 and 18 are photos of a deer trap and a radio-collared deer. All were fawns, four males and one female. Table 15 summarizes the physical data for the five deer. Technical data for the radio-transmitters and Michigan Department of Natural Resources identification numbers are located in Appendix C. Two of the radio-collared males (004 and 122) became accustomed to feeding on the cedar boughs in and around the second trap and each was caught three times after their initial capture, 004 on 4, 6 and 11 March, and 122 on 3, 7 and 13 March.

Winter home ranges and movements of the five radio-collared deer are shown in Figures 19 through 23. Home range and movement data are summarized in Table 16. Winter home ranges of all five deer overlapped. Deer numbers one and three, (004 and 122) were seen together with the same doe on two occasions, 2 and 9 March, but 004 moved out of his winter range 28 March and 122 after 22 May. Animals 122 and 092 were located together from 27 April to 26 June. On 20 July, both were located on northwest Neebish Island but had separated.

Between the time the five deer were trapped and when they moved to their summer ranges, none was observed (monitored) crossing the shipping or other river channels. Some readings, however, did locate deer on the edges of Neebish Island. A radio-collared deer also was seen by a Neebish Island resident 9 March near the slab dock at the southern portion of Munuscong Channel.

All five radio-tagged deer occupied the same general area on southern Neebish Island during February and March. Winter home ranges averaged 1.2 km^2. The first deer moved out of its home range 28 March and the last two moved after 22 May. Average distance between winter and summer

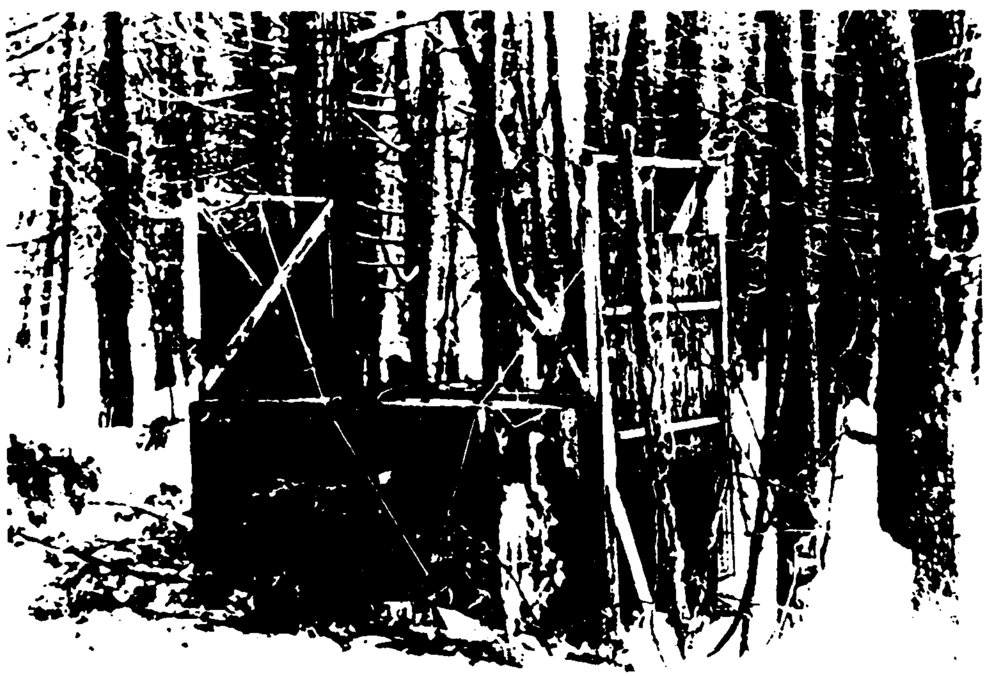

Figure 17. A box-type deer trap set and used successfully to live-trap deer in this study.

Figure 18. A deer recently captured and fitted with a radio-collar.

Table 15. Data on Radio-collared Deer Trapped on Neebish Island, Winter 1981.

Assigned No.	004	135	122	092	103
Date Trapped	7 Feb.	12 Feb.	14 Feb.	17 March	17 March
Trap Number	2	2	2	1	2
Sex	Male	Female	Male	Male	Male
Age at Capture	Fawn	Fawn	Fawn	Fawn	Fawn
Hind Foot Length (cm)	38.1	42.5	44.5	43.2	36.8
Chest Girth (cm)	76.2	83.8	81.3	83.8	76.2
Neck Girth (cm)	34.3	39.4	38.1	38.1	36.8
Estimated Weight (kg)	27.3	29	29	29	27.3

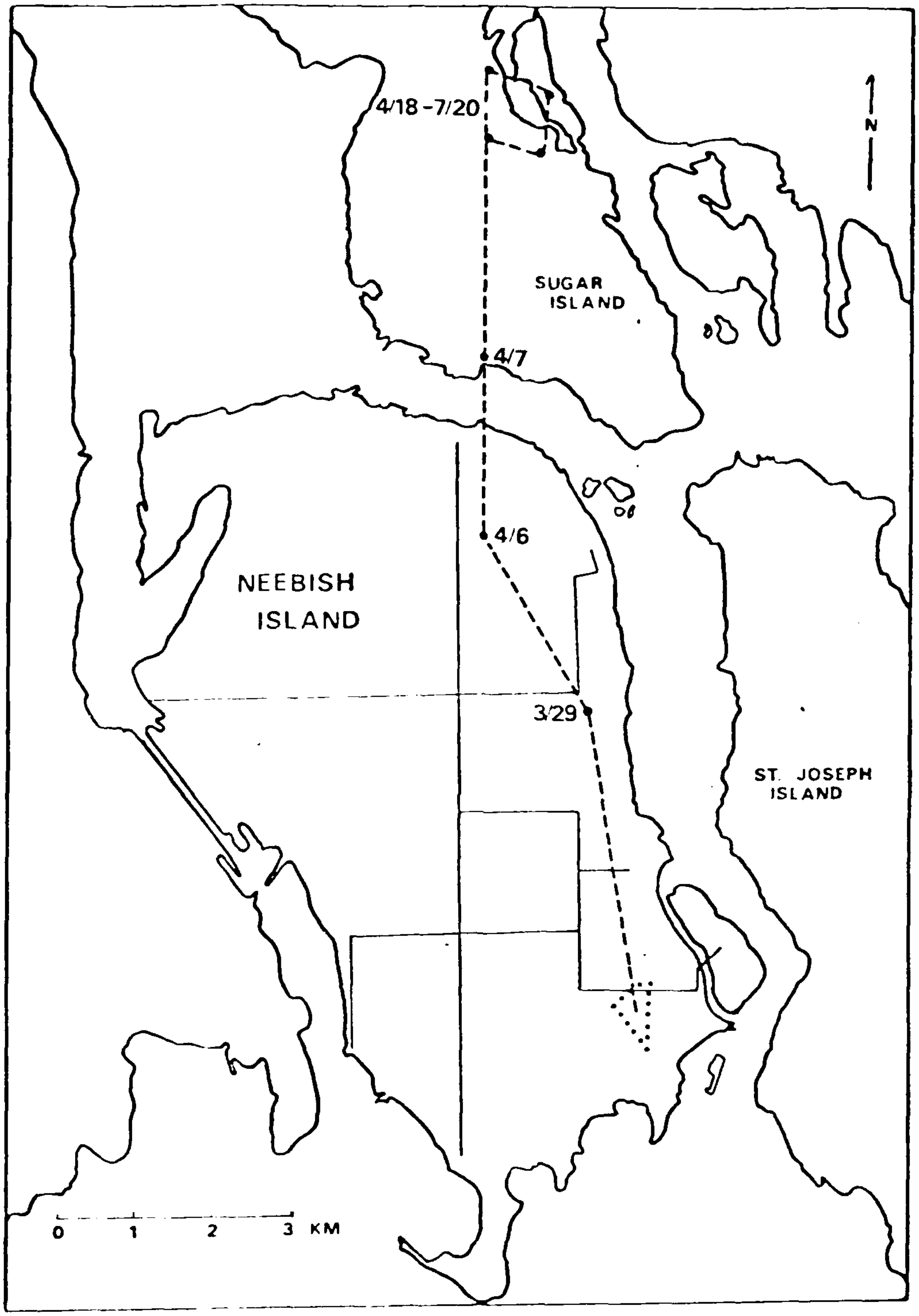

Figure 19. Winter home range (. . .) and movement to summer range (- - -) of deer 004. Dates and locations of telemetry fixes for movements out of the winter range are included.

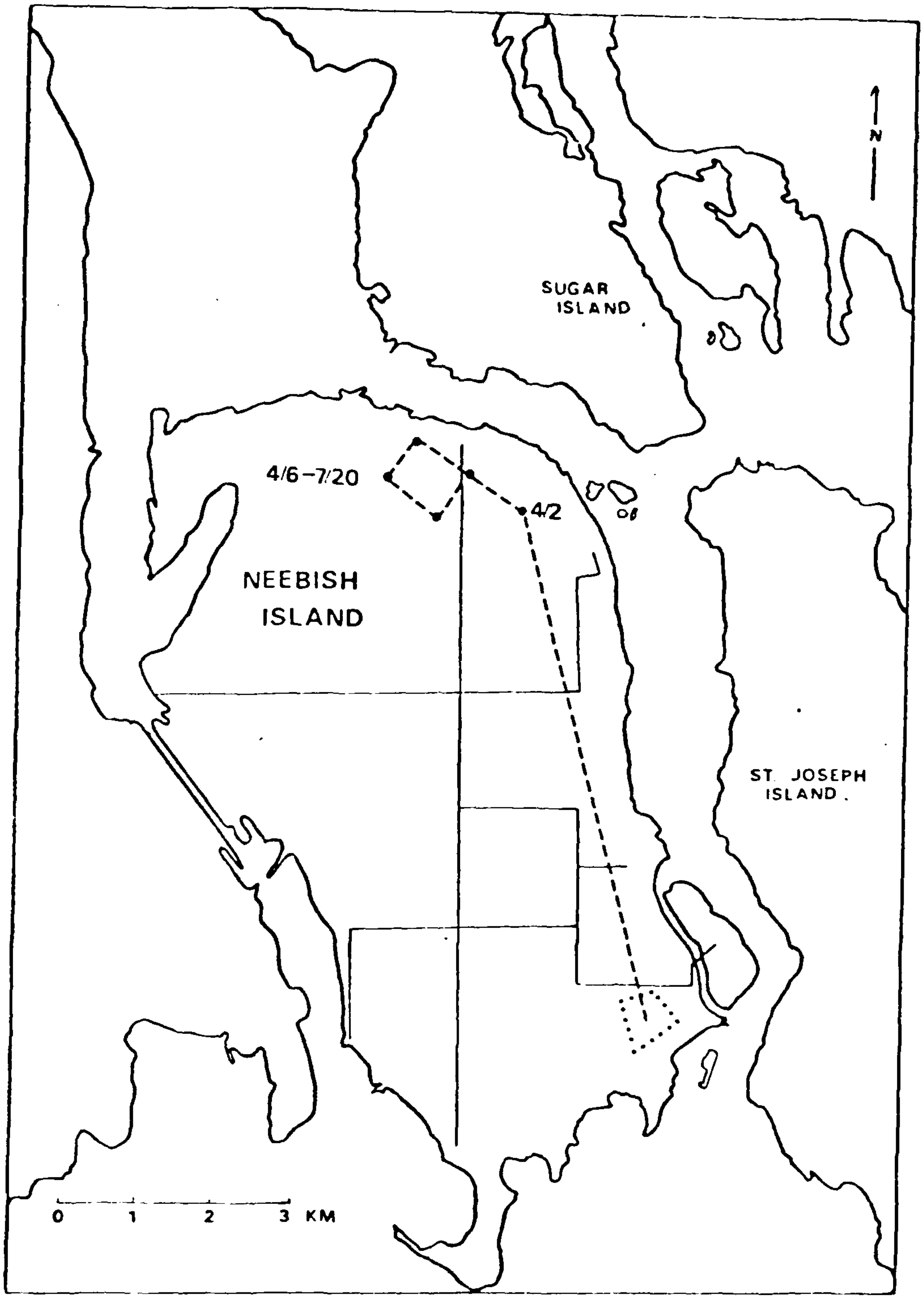

Figure 20. Winter home range (...) and movement into summer range (---) of deer 135. Dates and locations of selected telemetry fixes are included.

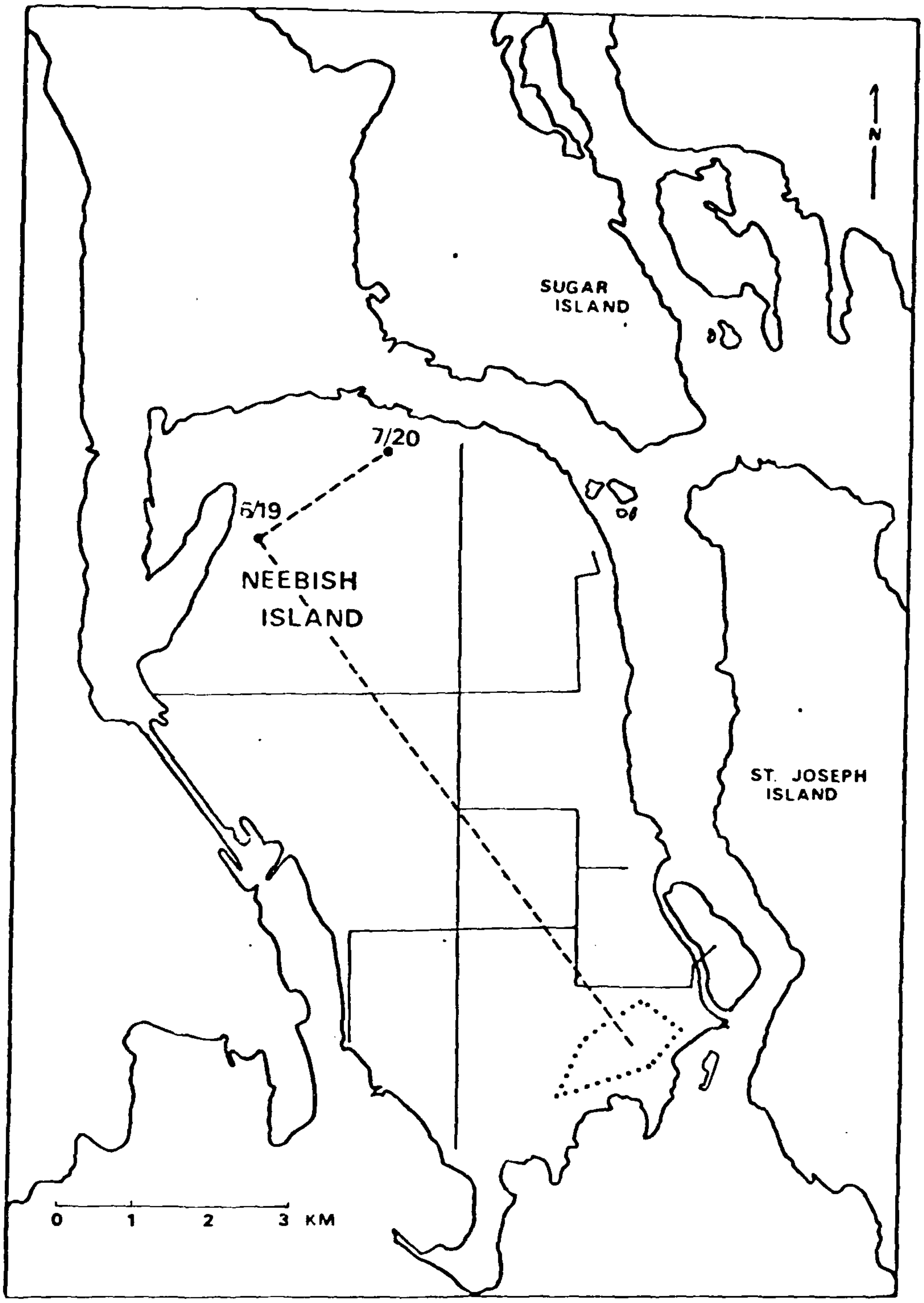

Figure 21. Winter home range (...) and movement out of winter range (---) for deer 122. Dates and locations of the most recent telemetry fixes are included.

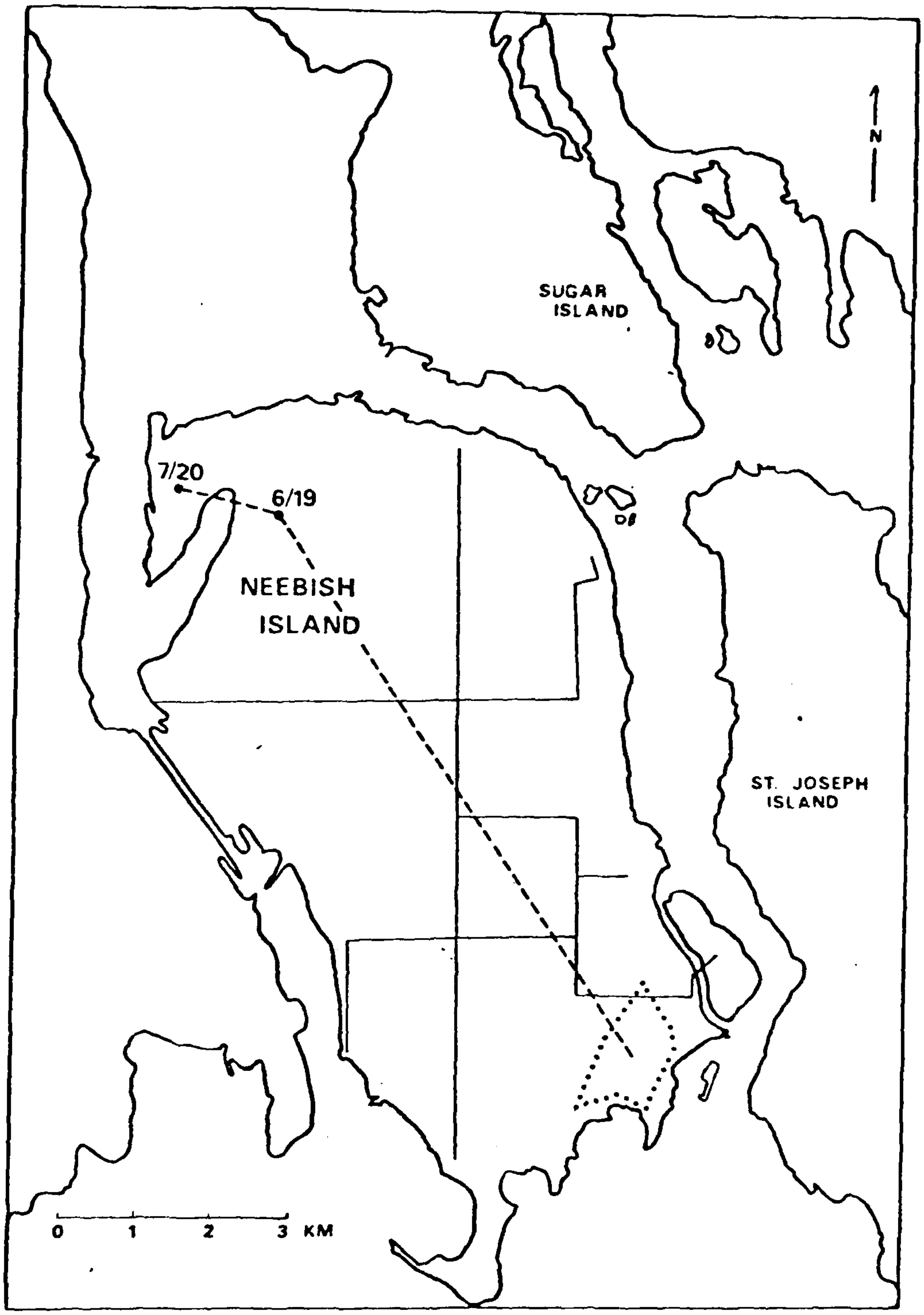

Figure 22. Winter home range (...) and movement into summer range (---) for deer 092. Dates and locations for the most recent telemetry fixes are included.

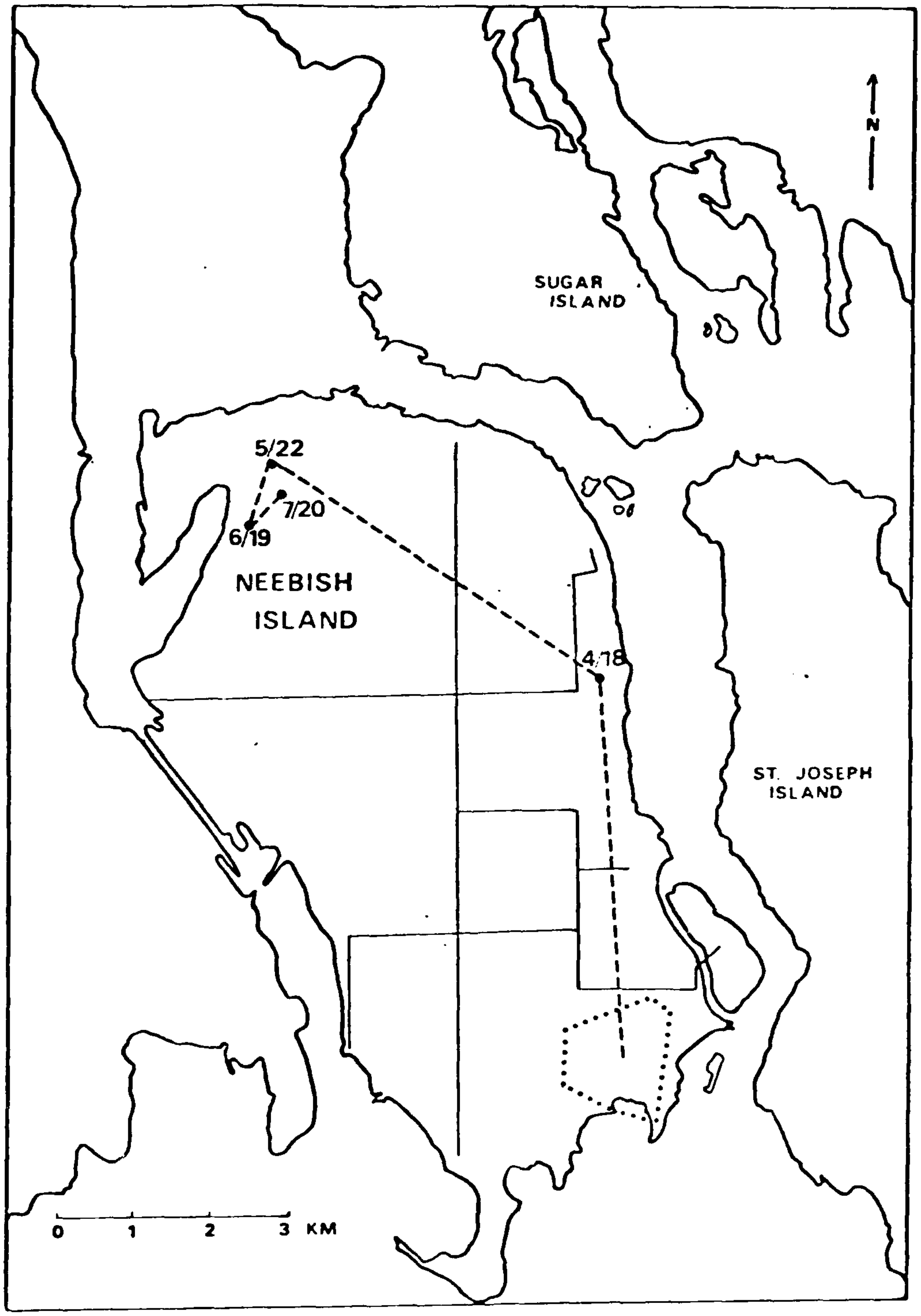

Figure 23. Winter home range (...) and movement into summer range (---) for deer 103. Dates and locations of selected telemetry fixes are included.

Table 16. Summary of Home Range and Movement Data for Five Radio-collared Deer on Neebish Island, 1981.

Deer No.	Date Trapped	Sex	Area of Winter Home Range (ha)	Average Daily Movement (km)	Approximate Distance Between Winter and Summer Ranges (km)	Number of Radio Locations
004	2/7	Male	50	.3	14	35
135	2/12	Female	50	.4	9	42
122	2/14	Male	140	.7	9	32
092	3/17	Male	100	.85	10	17
103	3/17	Male	150	.9	9	22

range is 10.3 km. Unlike winter home ranges the summer ranges of at least four of the deer do not overlap, it is not known for sure if summer ranges of 122 and 092 overlap. One animal moved off Neebish Island by swimming and established a summer range on Sugar Island. The other four radio-tagged deer remained on Neebish Island near its northwestern corner. Summer ranges of all five deer are totally separate from their winter ranges.

Movements of Individual Radio-Tagged Deer

Deer 004, a male fawn, was first trapped 7 February and again 4, 6 and 11 March. Until this deer began moving to its summer range (28 March), only two fixes placed the animal greater than 1 km from the center of the 0.5 km^2 winter range. Mild weather the last two weeks of February could account for this movement out of its winter range. By 2 April it had traveled to the north central portion of Neebish Island, 8 km from its winter range. On 6 or 7 April, 004 swam across Middle Neebish Channel to Sugar Island. It was next located on 18 April, and as of 20 July has been located four times in an areas of 1 km^2 on the eastern edge of Sugar Island, near Duck Island, 19 km from where it was trapped on 7 February.

Deer 135, a female fawn, was trapped and radio-collared on 12 February. On 28 March, 135 began moving north out of its winter range. This animal was next located on northcentral Neebish Island 2 April and has since been located in this area of the island ten times, 8 km from its winter home range.

Deer 122, a male fawn, was first trapped on 14 February, and again on 3, 7 and 13 March. It remained within its winter home range until at least 22 May. Between 22 May and 15 June, it moved north on Neebish Island and was next located near Sand Island on the northwest corner of Neebish Island 26 June and 20 July, 10 km from its winter range.

Deer 092, a buck fawn, trapped 17 March, was the only animal caught in trap number one. After this deer's capture and release 17 March, it was not located until 28 March. We could get no signal for ten days. On 28 March, it was located in the same general area the other four radio-collared deer occupied throughout the winter. Movement out of winter home range began between 22 May and 15 June, and 20 July it was located near Sand Island, 10 km from its winter home range.

Deer 103, a male fawn, was trapped 17 march. It began to move north out of its winter range 9 April and was located near Field Point 18 April, 6 km from its winter range. This male then traveled west and was located near Sand Island, on 27 April, 22 May, 15 and 16, June and 20 July.

Only two deer were seen crossing the ice in 1981. On 3 March, an adult deer was seen crossing the Munuscong Channel from southern Rains Island to St. Joseph Island and on 6 March another adult deer was seen crossing in the same location and direction. The second observed crossing occurred 24 hours after three Coast Guard cutters and an oil tanker traveled down the shipping channel.

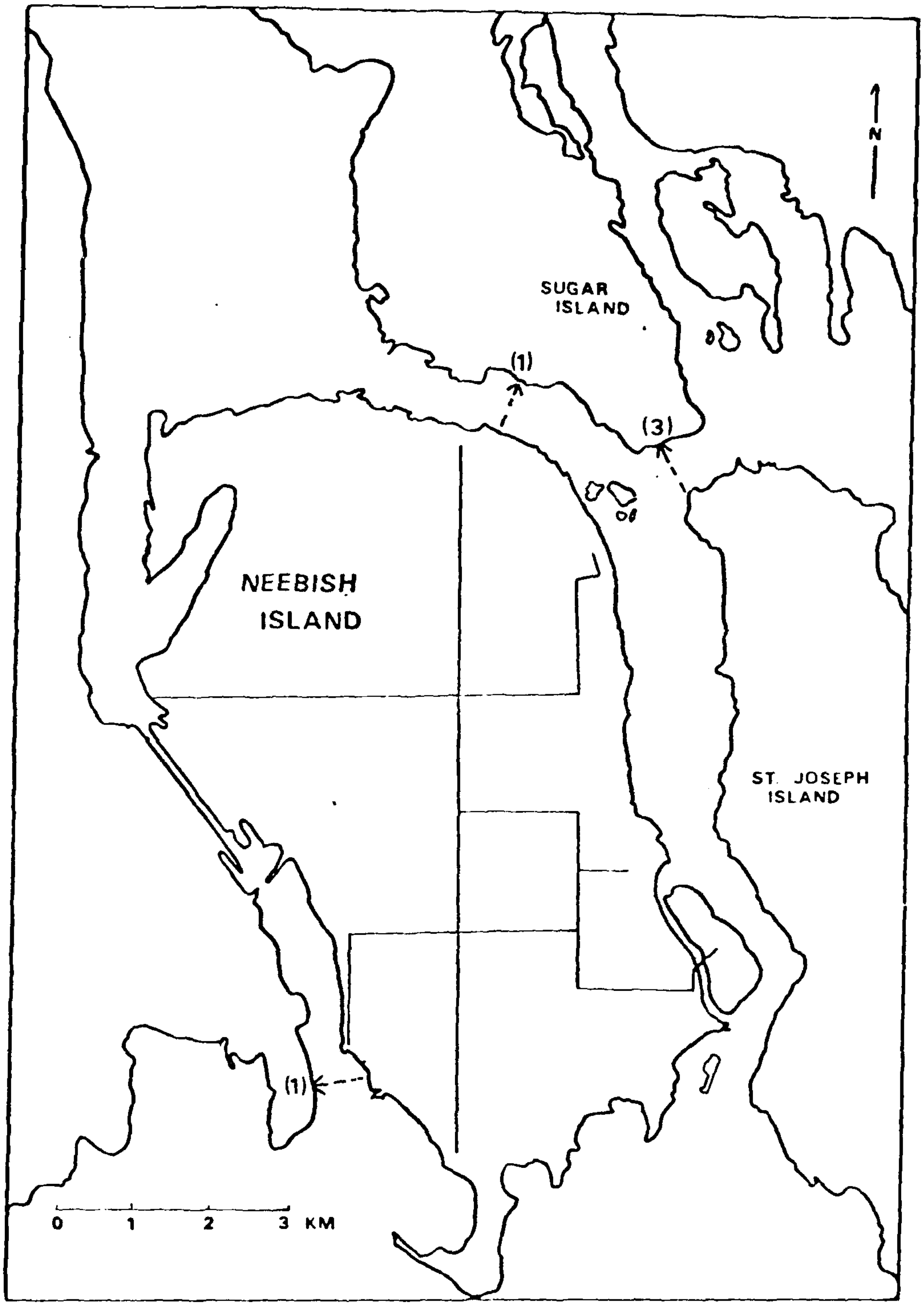

Figure 24. Locations and directions of deer seen swimming across the St. Mary's River. Number of animals observed is shown in parentheses.

At 6:00 P.M. on 31 March, a Neebish Island resident watched an adult deer swim across the southern part of West Neebish Channel from Neebish Island to the Michigan mainland. On 2 April, three deer, one fawn and two adults, were seen swimming together from Stribling Point on St. Joseph Island northwest to Sugar Island 6 or 7 April. An adult deer swam from St. Joseph Island to Rains Island, south of Johnson Point, on 11 June. Figure 24 shows the locations of deer seen swimming across various channels of the St. Mary's River.

During the study period, there were seven opportunities to observe tracks shortly after the passage of ships. These occurred on 20 January, 4, 5, 22 February, and 4, 5, and 22 March. These surveys after the passage of ships resulted in only one deer observed crossing the shipping channel. This animal was seen crossing from Johnson Point of Rains Island to St. Joseph Island, 22 hours after three Coast Guard icebreakers and an oil tanker passed headed downstream. No other crossings or turnbacks were observed within 48 hours of ship passage. It must be noted, however, that tracking was impossible 5, 6, and 7 February because of snowy, windy weather and 23 February because of warm temperature (0°C) and rain.

Number of Turnbacks

Of the 112 sets of deer tracks noted on the ice, 11 (10%) turned back to shore. All these turnbacks occurred when the ice was judged to be safe to cross since there had been no recent ship passage. Half (six) of the turnbacks were of deer turning back to Sugar Island after making an attempt to cross south to Neebish Island in January. All six deer (two pairs and two single animals) approached the frozen ship track (about 300 m from the shore of Sugar Island), moved parallel along it and then returned to Sugar Island. The ridge of broken ice making up the ship track contained large ice chunks which made the edges of the ridge approximately 0.75 meters high. These six turnbacks to Sugar Island represent more deer returning to shore than tracks showed crossing from Sugar to Neebish Island since five deer were known to cross Middle Neebish Channel during the study period.

The other five turnbacks occurred along Munuscong Channel at various times during the winter. No particular pattern resulting from recent ship passage or ice conditions could be discerned from these attempted crossings.

Browse Analysis

In order to determine food conditions for deer, data on plant species was collected from 320 available browse stems in four quadrants at each of 20 points at four locations. Six species, balsam fir, mountain maple, fly honeysuckle, beaked hazelnut, balsam poplar, and sugar maple had relative densities above 5% and made up 76.9% of the browse samples. Thirteen species made up the remaining 23.1%. Table 17 lists species of browse samples and their relative densities. From these relative densities and food preference ratings (Table 4), a browse condition index, preference rating index and pressure index were computed for each

Table 17. Relative Densities for the 19 Species of Browse Sampled at Three Locations on Southern Neebish Island and one Location on St. Joseph Island, Winter 1981.

Species	Number of Stems Sampled	Stands 1	2	3	4	Relative Density %
Balsam fir (*Abies balsamea*)	90	18	10	0	62	28.1
Mountain maple (*Acer spicatum*)	41	16	15	10	0	12.8
Fly honeysuckle (*Lonicera canadensis*)	37	3	23	11	0	11.6
Beaked hazel (*Corylus rostrata*)	29	8	5	16	0	9.1
Balsam poplar (*Populus balsamifera*)	25	7	3	4	11	7.8
Sugar maple (*Acer saccharum*)	24	0	9	15	0	7.5
Black ash (*Fraxinus nigra*)	15	4	0	11	0	4.7
Quaking aspen (*Populus tremuloides*)	12	2	3	7	0	3.8
Striped maple (*Acer pensylvanicum*)	8	3	5	0	0	2.5
Red-osier dogwood (*Cornus stolonifera*)	8	0	1	5	2	2.5
Red maple (*Acer rubrum*)	8	8	0	0	0	2.5
White cedar (*Thuja occidentalis*)	6	1	1	0	4	1.9
Yellow birch (*Betula lutea*)	4	2	2	0	0	1.3
Michigan holly (*Ilex verticillata*)	3	3	0	0	0	.9
White spruce (*Picea glauca*)	3	0	1	0	2	.9
Serviceberry (*Amelanchier sp.*)	2	1	1	0	0	.6
Gooseberry (*Ribes sp.*)	2	1	1	0	0	.6
Alder (*Alnus rugosa*)	2	1	0	1	0	.6
Red Oak (*Quercus rubra*)	1	1	0	0	0	.3
Totals	320	80	80	80	80	100.0 %

Table 18. Browse Data for Four Stands Sampled.

Stand	Browse Condition Index	Preference Rating Index	Pressure Index	Minimum Browse Stems per Hectare
1) Tally-Ho Swamp	1.9	2.5	4.8	775
2) SE Neebish Island	1.8	2.4	4.3	1563
3) Rains Island	3.0	2.7	8.1	2222
4) St. Joseph Island	0.12	3.2	0.4	1923

stand (Table 18) (Beals et al. 1960). Minimum densities of browse per hectare are also listed in Table 18.

Stand three on Rains Island, had the highest value for the browse condition index (3.0) indicating that this stand has the most browse damage of the four stands sampled. (A value of 4 would indicate all stems sampled were totally browsed and a value of 0 would indicate all stems sampled were not browsed). Stand four, on St. Joseph Island, with a browse condition index of 0.12 was browsed very little. Browse condition indices for stands two and three (1.9 and 1.8 respectively) indicate moderate browsing.

According to the preference ratings, stand four with a value of 3.2 has the poorest quality food in terms of browse species available, while stands one, two and three have lower values indicating better quality browse. (A value of 1 would indicate first choice food and 4 would indicate fourth choice food). The major reason for the low quality of browse in the St. Joseph Island stand is that 78% of the stems sampled were of balsam fir, a third choice food. Though the stand is mostly mature cedar (63%), the understory is dominated by balsam fir saplings.

Multiplying the browse condition index and preference rating gives the pressure index which is an indication of the overall browse condition. Based on the amount of browse damage and species available, stand four (St. Joseph Island) is in the best condition, followed by stands two, one and three, in descending order.

Qualitative comparisons of the stands sampled on Neebish and Rains Island versus the St. Joseph Island stand shows white cedar (a first choice food) commonly growing below the browse line on St. Joseph Island. On many cedar trees branches with available browse extend to ground level. On the Neebish and Rains Island stands there is essentially no cedar browse within a deer's reach.

PART V: DISCUSSION

Mammal Activity On The Ice

St. Mary's River

Deer: In general, deer movements on the St. Mary's River in 1980-81 were similar to movements in 1979-80. In both winters, over 90% of observed crossings were on channels adjacent to Neebish Island (Middle Neebish and Munuscong Channels). Migration towards Neebish Island occurred in late January both years and early February in 1980, and crossings of southern Munuscong Channel between Neebish and St. Joseph Islands were frequent in both directions in 1980 and 1981.

Data from 1979-80 indicated that migration of deer from Sugar Island towards Neebish Island occurred through the first week in February but in 1980-81, such migration occurred only in January. Weather in December 1980 and January 1981 was more severe than normal. Consequently, movements of deer to Neebish Island may have occurred earlier than in 1979-80 when weather during this period was milder than normal. It is probable that many deer crossed Middle Neebish Channel during December and early January but data were not collected before 13 January.

Data from the Munuscong Channel provided a comparison between the two years because this channel was surveyed extensively both in 1979-80 and 1980-81. In 1979-80, 216 crossings were observed between Mirre Point and Everens Point and in 1980-81 there were 92 crossings. The major difference between the two winters was that in 1979-80, 108 (50%) of the 216 crossings were between Mirre and Johnson Points while the major crossing point on the Munuscong Channel in 1980-81 was to and from the south end of Rains Island. An explanation for the decreased deer activity immediately north of Johnson Point is activitiy of people and dogs around a cabin near the Point. This cabin was not occupied in the winter 1979-80.

Track information from 1979-80 and 1980-81 suggested that most of the crossings of Munoscong Channel, between Mirre and Everens Points, were made by a small number of deer or groups of deer. The highest crossing rates for this channel were in March in 1980 and February in 1981. In 1980, most crossings near Mirre Point (27 or 42) occurred in mid-March but in 1981 no crossings were noted there in March. Nineteen of the 20 crossings observed in that location occurred in January.

Overall, observed deer crossing activity on the Munoscong Channel was lower in 1980-81 than the winter before (92 and 216 respectively), and total estimated crossings were lower (406 and 514 respectively).

In 1980, the estimated number of deer crossing the channel on a regular basis was less than 40. In 1981, we estimated a maximum of 12 deer crossing regularly. These deer apparently crossed the Munoscong Channel from Neebish to St. Joseph Island to feed on cedar. Because mild weather in February and March 1981 provided good grazing conditions for deer in fields of Neebish Island, demand for the cedar on St. Joseph Island was probably lower and fewer deer crossed the channel.

Decreased crossing activity in the Mirre Point area may have been due to the abundance of open fields and available grass in that vicinity on Neebish Island. In contrast, the area of Neebish Island south of Johnson Point, where crossing activity was the highest in 1980 and 1981, is not close to fields, and the deer wintering there may have continued to use cedar browse on St. Joseph Island.

Winter home ranges (50-150 ha) of the fawns radio-collared on Neebish Island were smaller than home ranges of deer (162-486 ha) in east central Minnesota (Rongstad and Tester 1969) but were smaller to winter home ranges (41-150 ha) of fawns in Iowa (Gladfelter 1978). Distances between summer and winter ranges fall within reported maximum distances (52 km) of deer in the Great Lakes Region (Verme 1973, Fanter 1977). Movement out of the winter range began in late March when daily temperatures were consistently above freezing. It is apparent, however, from our study that temperature is not the only factor determining the time of spring dispersal. Five radio-collared deer, which occupied the same winter range, dispersed between 27 March and 22 May.

All five animals moved north out of their winter range to north Neebish Island and Sugar Island. It is probable that most of the deer within their dispersal range also winter on southern Neebish Island. Verme (1963) found that deer in Upper Michigan have directional seasonal movement, and there is little overlap of summer range of deer from other yards. Only one of the five radio-collared deer moved off of Neebish Island. (Five is a small sample but if considered representative of the winter population on Neebish Island, then one-fifth of the 350-500 estimated population, or 60-100 deer cross the river to get to and from Neebish Island in their seasonal migration. Because all five radio-tagged deer were fawns, their movements probably also indicated movements of their mothers and siblings because family groups tend to remain together for up to two years (Hawkins and Klimstra 1970, Gladfelter 1978).

In both winters, coyote activity was greatest in late January and February. The major difference between the two years was the number of observed crossings; 83 in 1980 and 10 in 1981. The 10 crossings in 1981 were all across shipping channels, and estimated total crossings of shipping channels was 50 in 1980 and 32 in 1981. It is not possible to determine whether the difference in crossings was due to the lower number of aerial surveys in 1981 (25 in 1980, 5 in 1981) or a decrease in coyote activity or coyote numbers.

One fox crossing was observed in 1981, as compared to 34 in 1980. Twenty-two of the 34 observed fox crossings in 1980 were on channels surveyed 25 times in 1980 and only five times in 1981. Although the sample size of only one observed track in 1981 was small and tracking conditions were poor, the apparent great reduction in fox tracks seen suggests that fox activity on the ice in 1981 was reduced from that of 1980.

In 1980-81, all eight observations of crossings by dogs were on the Munuscong Channel. In the winter of 1979-80, 17 (70%) of the 24 dog crossings were on this channel. In both years, these crossings were made by one or two groups of two dogs crossing and recrossing the channel.

Whitefish Bay

The numbers of deer north of Sault Ste. Marie, Ontario along Whitefish Bay were low and for the most part were confined in winter to the Walls Lake deer yard. This yard was believed to support roughly 100 deer during the winter of 1980-81. No tracks of deer were observed on the ice of Whitefish Bay during the study.

Though moose populations are not considered high in the vicinity of Whitefish Bay, they are present in small numbers along the shore. Tracks were observed on the ice of Whitefish Bay during the winter of 1980-81. Home ranges of approximately seven or eight moose are believed to border the Whitefish Bay shoreline. Undoubtedly, several others are within easy dispersal distance of the bay.

The number of coyotes along Whitefish Bay appears to be substantial. Fish remains left by commercial fishermen attracted coyotes out onto the ice. Coyotes are probably the most common wild canid along the bay.

Though present, fox populations appear to be relatively low in the vicinity of Whitefish Bay. The low number of fox along the bay is probably the result of high coyote populations.

Timber wolf numbers in the Whitefish Bay area are low. Though several individuals were within dispersal distance of Whitefish Bay, no timber wolf tracks were observed on the ice.

Condition of Deer on Neebish Island

The purpose of the browse survey and the dead deer search was to determine if the deer wintering on southern Neebish Island are nutritionally stressed and undergo high mortality. If so, any mortality from winter shipping would reduce the population further. Winter shipping could prevent migration from Sugar Island thus removing a portion of animals from the wintering population that would have been lost from starvation and other causes in the Neebish deer yard.

Browse pressure indices (an indication of browse damage and quality of browse available) resulting from the browse surveys indicated that the two stands sampled on Neebish Island and the stand on Rains Island had very heavy browse pressure while the stand on St. Joseph Island had light browse pressure (Table 18). Overall browse on Neebish Island is poor with white cedar virtually unavailable.

Low quality food, however, if consumed in liberal amounts, can maintain deer over the winter. The average minimum browse per hectare on the Neebish Island stands sampled was 1620 stems, as compared to the Apostle Island (Beals et al.) of 890 stems per hectare, on stands with comparable pressure indices. The quantity of low quality browse is high on Neebish and Rains Islands, possibly an important factor for maintaining the population.

In 1981, deer on the island had an early opportunity to graze in the fields because of the mild weather the last two weeks in February. We have no way to quantify the contribution that grazing makes to the nutritional condition of the deer on Neebish Island but the early opportunity to graze in the fields in 1981 was probably a factor in reducing nutritional stress and possibly mortality associated with the poor browse conditions in this yard.

Winter mortality in 1981 was found to be less than 15% which is not excessive. Westover (1971) in the winter of 1968-69 reported 40 (13% of population) dead deer (12 died of starvation, two drowned, and 26 died of unknown causes) in a yard in Upper Michigan where the winter deer density was eight deer/km^2 and the total yard population was 301 deer. These animals were found by chance encounters as no systematic deer search was made. On Neebish Island, with a winter deer density of about 27 animals/km^2, winter mortality was estimated to be 37 deer. The yard on Neebish Island is not overly crowded; heavily used deer yards in Upper Michigan have had up to 153 deer/km^2 (Fanter 1977).

Other indications of the condition of deer on Neebish Island include the adult to fawn ratio and the bone marrow fat analysis. The proportions of fawns observed on Neebish Island in 1980 and 1981 (29% and 21% respectively) suggested that the population was in good condition (Robinson, et al. 1982). The 65% bone marrow fat of a buck fawn indicates the animal was in good condition at the time of death (killed by dogs).

Estimates of Wolf Numbers and Activity in the Vicinity of Whitefish Bay and the St. Mary's River

As Table 5 shows, the estimated winter range size (km^2) of the timber wolves permanently inhabiting portions of the study area is comparable to the winter ranges of wolves in other eastern boreal forest habitats. The population density estimate for the study area is considerably below that found by other studies in similar habitats (Table 19). Among the factors that may contribute to the comparably low densities are:

1. The wolf population in the study area is being exploited; whereas hunting and trapping were not mortality factors in other study areas.

2. Human habitation and competition by people for prey of the wolf (i.e., deer, moose) may be limiting available food for wolves.

3. The actual boundaries of the pack territories were not known, and thus our calculations may be biased.

These results suggest that though the population density of timber wolves in the study area is well below the maximum possible, the winter territory size of individual packs appears to have remained within the expected size range. The mean group size of the nine packs estimated in Table 5 is 2.8 to 3.2. This compares closely with the mean group size of 2.8 reported for exploited timber wolf packs in Northern Minnesota during the early 1950's (Stenlund 1955). This indicates that not only are

Table 19. Reported Winter Territory Sizes and Population Densities of Timber Wolves in Eastern Boreal Forest Habitats. Sample size is shown in parentheses.

Location	Territory Size (km^2) Mean	Range	Population Density (km^2/wolf)	Source
Ontario	228(9)	70-462	82-114	Present study
Isle Royale		75-544	18-26	Mech (1966), Jordan et al. (1967), Wolfe and Allen (1973), Peterson (1977)
Ontario	175(4)	104-311	26	Pimlott et al. (1969)
Minnesota	192(4)	93-326	44	Stenlund (1955)
Minnesota	150(4)	125-183		Mech (1977)
Minnesota	110(5)	52-145	10-18	Van Ballenberghe et al. (1975)

portions of the study area uninhabited by wolf packs, but that the size of the packs is lower than average pack sizes (Table 19).

Food Resources of Timber Wolves in the Study Area

The amount of available food for wolves near Whitefish Bay and the St. Mary's River is an important factor for two reasons. First, the location of deer yards and moose wintering areas near the Ontario shoreline would attract wolves from interior territories, thus increasing contact with the ice bridge to Michigan. Second, deer yards along the Michigan shoreline might function to induce wolves to stay or return, once a wolf arrives on the Michigan shore.

Of the ten packs identified in Figure 9 as wintering in the vicinity of Whitefish Bay and the St. Mary's River, two were reported to frequent garbage dumps (Packs I and II), three depended on moose (Packs III, IV and VIII) and four frequented deer yards (Packs VI, VII, IX and X). The Echo Lake, Desbarat Lake and Cockburn Island deer yards, which wolves frequent, are all located within 30 km of Michigan deer yarding areas. This places an estimated seven to nine timber wolves within a short dispersal distance to winter food sources in Michigan.

Though the dispersal corridor which wolves must travel to reach deer yards in Michigan via Whitefish Bay is much longer (estimated 90 to 110 km), it, too, is well within the dispersal distances reported by other studies in eastern boreal forests (Pimlott et al. 1969, Mech and Frenzel 1971; Van Ballenberghe et al. 1975). Despite the availability of prey for wolves and possible ice bridges for them to cross, survival of wolves on the Michigan mainland is not assured. Hunting and human disturbance are major factors contributing to the scarity of wolves in Upper Michigan (Hendrickson et al. 1975; Weise et al. 1975; Robinson and Smith 1977).

Estimating the Frequency of Timber Wolves Crossing the Ice

Whitefish Bay

Though no quantitative information was collected on wolf movements across Whitefish Bay, a theoretical scenario could be developed from the literature. Based on the reports of local trappers and other sportsmen, about 14 to 18 timber wolves live within 30 km of the Whitefish Bay shoreline and within 110 km of deer yards on the Michigan mainland. As previously stated, movements of this distance are well within known dispersal distances. It appears, from the literature, that the young subordinate individuals are the most likely members of the pack to disperse (Banfield 1953; Kuyt 1962; Peterson 1979; Van Camp and Bluckie 1979). The actual percentage of juveniles which do disperse is dependent upon several factors, and thus is a highly variable parameter. Mech (1973) derived an estimate that 11% of the wolves present in his study area (N=92) were pairs or loners dispersing. If only juveniles are considered, this estimated percentage would increase.

Van Ballenberghe et al. (1975) reported an autumn age ratio of 40% pups, 29% yearlings and 31% adults (N=40). Pimlott et al. (1969)

reported a comparable age ratio of 31, 17, and 52 percent pups, yearlings, and adults, respectively. It may be assumed, therefore, that from 48 to 69 percent of the wolves in the study area are of the age category that may disperse. It has been reported that exploitation of wolf packs causes an increase in pup percentages (Fuller and Novakowski 1955; Kelsall 1968). The percentage of young wolves in exploited packs may be higher. Of the estimated 14 to 18 wolves near Whitefish Bay, seven to 12 would conceivably be of the dispersal age. Of these, an estimate of 16 to 23 percent, or one to three wolves would disperse. The direction of dispersal is difficult to account for. Random dispersal may account for 25% of the individuals encountering Whitefish Bay. The topography of the land and the rivers leading into the bay may facilitate travel and increase directional movements towards Whitefish Bay to a level of 30 percent, or about one-third to one one wolf per year, or one to three wolves per three years.

It is felt that most crossings would occur during late winter. This assumption is based on a significant increase in perpendicular movements from shore by coyotes and that both groups of timber wolf tracks found on the ice of the St. Mary's River occurred in March.

During March, it was estimated that 11% of the coyote tracks (N=44) on Whitefish Bay traveled in excess of five km from shore. The crossing rates for individual animals would presumably be higher. Literature suggests that timber wolves may be more inhibited from traveling across certain ice conditions than coyotes (Peterson 1979). Assuming that the likelihood of crossing by wolves would not exceed that of coyotes, a maximum estimated crossing rate of 0.04 to 0.09 wolves per year or one wolf crossing per 11 to 27 years might be expected. No doubt wolves from interior packs in Canada also would disperse across the bay and increase the frequency of crossings. During the period from 1959 to 1981, three crossings between the Ontario mainland and Isle Royale are believed to have occurred resulting in a rate of about one crossing per seven years (Mech 1966; Jordan et al. 1967; Wolfe and Allen 1973; Peterson 1977; Allen 1979). It would appear that though crossing rates by timber wolves on Whitefish Bay are low, crossings have occurred periodically in the past, and attempts of wolves to cross Whitefish Bay are likely to occur in the future.

St. Mary's River

Though the majority of the efforts were put forth surveying Whitefish Bay, the only wolf tracks located on the ice were found on the lower St. Mary's River. An estimated seven to 16 wolves frequented areas within 30 km of the St. Mary's River. Of these, the two to four wolves inhabiting Cockburn Island are felt to be the most likely candiates for dispersal into Michigan. Though deer yards on Drummond Island, Michigan, are within two to three km of the Cockburn Island pack, travel to the nearest Michigan mainland deer yard requires a movement of approximately 70 km. This distance is known to have been traveled by timber wolves within a 24 hour period (Mech 1966, Burkholder 1959). Such a crossing would probably involve traversing Potagannising Bay between Drummond Island and St. Joseph Island. This route would be likely for the following reasons:

1. Potagannising Bay contains approximately 69 islands. This island complex would allow wolves to travel from Cockburn Island to the Michigan mainland without being more than 2-3 km from land.

2. Deer winter on several of the larger islands in Potagannising Bay. This would provide a readily accessible source of food for dispersing wolves.

3. Ice along this prospective route is usually solid from mid-January to late March.

It would appear that movements to the west are the most probable for Cockburn Island wolves. Attempts to travel north to the Canadian mainland would involve crossing approximately 28 km of ice. Travel to Manitoulin Island to the east would require crossing the Mississagi Strait which remains open much of the winter due to strong currents (Pers. Comm. Scott Jones, Arthur Bailey).

Trapping records, of Cockburn Island trapper Erwin Mitchell, show that the timber wolf catch has been increasing over the past three years, while the coyote catch has declined (Table 20). With approximately equal trapping effort each year, it is likely that wolf numbers have increased while coyotes have declined. The deer population on Cockburn Island is reportedly also on the decline (Pers. Comm. Scott Jones). The replacement of coyotes by wolves is an occurrence reported in other studies (Mech 1966; 160).

If the Cockburn Island pack produces five or six pups (Mech 1970: 118) which had a ten month survival rate of 48% (Mech 1970: 60), the 1982 winter pack would contain from four to seven members. This would result in a density of one wolf per 24 to 43 km^2. Densities of this level are comparable to the maximum densities reported in the primary wolf range in other parts of Ontario, Isle Royale and Minnesota (Table 20).

If winter deer densities of the Lake Superior watershed are comparable to those of Cockburn Island, the deer population for the Island would be approximately 600. At an annual consumption rate of 18 deer per wolf (Mech and Frenzel 1971, Kolenosky 1972), approximately 72 to 126 deer would be taken by wolves each year. This would result in an annual predation rate of 12 to 21 percent.

Forays and dispersal movements of wolves from the Cockburn Island pack are likely to occur if the Cockburn Island wolf pack is not seriously depleted by trapping, and if predation, amounts of available deer browse or weather conditions continue to depress deer populations. The frequency of timber wolves coming in contact with the ship track along the lower St. Mary's River could occur at a rate once or twice per season.

Table 20. Summary of Trapping Success of Erwin Mitchell on Cockburn Island During the Autumns of 1978-1980.

Year	No. of Timber Wolves Captured	No. of Coyotes Captured
1978	1	13
1979	2	4
1980	3	3

Estimating the Frequency of Moose Crossings of Whitefish Bay and the St. Mary's River

As Salverson (1929) and Mech (1966) reported, both calves and adult moose may have trouble walking on wind blown ice. Even a slight slippage, as reported on 13 January, may be enough to discourage travel on ice by moose. The actual peak in moose activity on the ice occurred during early February when mean daily snow depths were at the maximum recorded for the winter (Table 1). The apparent reliance on snow cover by moose traveling on ice, coupled with their reluctance to travel far from shore (Table 6) suggests that the frequency of moose crossing Whitefish Bay would be very low. Moose are believed to have arrived on Isle Royle from the Canadian mainland by swimming the 27 km distance (Mech 1966).

Though crossings were not observed, moose populations in Canada near the St. Mary's River appear to be high enough to make crossings a fairly common occurrence. A moose was reported by the OMNR to have swum the river between Squirrel Island and Sugar Island in April. This individual apparently returned to Canada in April. The mailmen of Sugar Island and Neebish Island state that a cow and calf were inhabiting Sugar Island and a bull was on Neebish Island in June 1981. It appears from these cursory observations that though winter ice crossings of the St. Mary's River are not unlikely, most crossings apparently occur during ice free months by swimming.

Effects of Winter Shipping on Mammals

A major concern of this study is the effect that winter navigation may have on the immigration of timber wolves into Upper Michigan from Ontario (U.S. Army Corps of Engineers 1979). The endangered status of this animal in the United States and the extremely low number of resident wolves in Upper Michigan increases this concern.

From their review of the available literature, Robinson and Fuller (1979, 1980) determined that wolf dispersal into Upper Michigan from Ontario occurs periodically. Mech (1966: 91) summarized the conditions necessary for immigration of wolves to Isle Royle, and, therefore, factors likely to be applicable to crossings of Whitefish Bay and the St. Mary's River as follows: (1) a high wolf population or food shortage in the emigration area, causing "pressure" for animals to seek a new area, (2) a solid snow-covered "ice bridge", (3) a positive reception given newcomers by residents (both wolf and human in Michigan), and (4) adequate population of prey to sustain immigrants. Timber wolf densities adjacent to Whitefish Bay and the St. Mary's River are lower than in the primary wolf range of the northeastern boreal forests. Prey densities along the Canadian shoreline of Whitefish Bay and the St. Mary's River mainly consists of prey in small deer yards and a few pockets of moose activity. The prey densities in Michigan appear to be adequate to support a population of wolves (Hendrickson et al. 1975, Weise et al. 1975). Conflicts between resident wolves and immigrating wolves would be extremely low. Potential human conflicts is a more serious factor (Robinson and Smith 1977). It would appear that the two major factors affecting the migration of wolves from Canada would be periodic declines of prey populations in Canada and presence and quality of an ice bridge to Michigan. Peterson (1977) reported "cautious" and "reluctant" behavior by wolves on Isle Royale to cross from one type of ice to another. He also observed wolves returning to the island after encountering ice, "composed of many small pieces frozen together" (Peterson 1977). Mech stated that it seems likely that the farther from shore wolves travel, the more reluctant they are to travel over rough ice (Robinson and Fuller 1980). Winter shipping, and resultant changes in the support capacity; texture and cover of the ice, and the presence of passing ships, might limit wolf dispersal to Upper Michigan, though no quantitative data was collected on the interaction of wolves with a ship track. We believe that this possible disruption of timber wolf movements would occur at the highest rate on the lower St. Mary's River where wolves are more frequent visitors.

As a result of two winters of study, it is apparent that winter shipping affects deer on two portions of the St. Mary's River, Middle Neebish and Munuscong Channels. Data collected in 1980 indicated passage of ships greatly affected deer crossing the river, with 39 of 41 deer attempting to cross the river being turned back to shore within 24 hours after passage of a ship. Poor tracking conditions after ship passages in 1981 prevented collection of similar data on turnbacks. Data collected in 1981, for animals that turned back from the ship track when the ice was safe to cross, indicated that movements of deer are also affected by the physical characteristics of the ship track. Six of 11 deer attempting to cross Middle Neebish Channel in 1981, probably turned back because of the height of the ice along the edge of the ship track. With regular ship passage, the large blocks of ice might be broken into smaller chunks and the height of the ridge might be reduced, but this also might cause less firm ice for deer crossings.

Overall, the winter of 1980-81 was not detrimental to the deer wintering on southern Neebish Island. Winter mortality caused by interruptions of deer movements by winter shipping could be additive to other winter mortality. Winter shipping could cause stress and possible mortality among the deer by reducing the fitness of animals if they are delayed or prevented from getting to the winter yard on Neebish Island, prevented from getting to needed food resources on St. Joseph Island, or by falling through thin ice and drowning.

Three conditions are believed to inhibit the crossing on ice by moose. These are a snow-free covering on ice, great distances between shores and the support capabilities of the ice. Frequent shipping in the winter would reduce the quality of ice travel for moose. Moose are susceptible to falling through thin or unstable ice and drowning (Peterons 1955, Peterson 1977, Allen 1979, Mytton and Keith 1979). Shipping operations may reduce the support capacity of the ice in the shipping channel. The large irregular chunks of ice resulting from ship passage would also result in precarious footing c nditions for moose. Winter crossings by moose of Whitefish Bay and the St. Mary's River, however, are extremely infrequent. Because moose are able to swim long distances, and because they are more likely to cross the channel during ice-free seasons, the total impact of winter shipping on their movements is probably negligible.

Based on information gathered by Robinson and Fuller (1980) and the present study, disruption by winter shipping of coyote and red fox movements across the ship track is probably not serious, provided low temperatures facilitate refreezing, and ship traffic is relatively light.

PART VI: RECOMMENDATIONS FOR FURTHER STUDY

Wolf Studies

These studies point to the need for further information on the Cockburn Island wolf pack. One or two winters of gathering basic data on the pack size, prey species availability, and frequency of ice travel by this pack should be conducted. Because of dense cover and unfavorable tracking conditions, radio-tagging of two to three wolves on Cockburn Island during the coming fall would yield much information. Cursory examination of the deer yard on Cockburn Island also would provide insight about the resident deer population.

In addition, with anticipated reduction of prices for long furs and resultant decrease in trapping pressure, combined with a possible effect of removal of the bounty on wolves in 1972 in Ontario, wolf numbers may increase on the Canadian side of the study area. In 5-10 years the potential for wolf immigration to Michigan could be considerably higher than at present. On the other hand, unanticipated events, such as large scale urban or agricultural development, could reduce the wolf population in the study area.

Monitoring Wolf Numbers and Movements

We recommend that aerial monitoring of tracks of mammals be continued on a weekly basis with ground surveys used to verify tracks. The methods developed in 1980 continued to be satisfactory for most species. Because of the scarcity of the timber wolf, however, it is very difficult for 1-2 workers to locate wolf tracks over the 140 km length of the study area. A systematic survey of trappers by interview asking numbers and locations of wolf signs encountered, along with a review of fur records kept by the OMNR, would provide an index of wolf abundance. Information from such surveys could be compared with information gathered by surveys presented in this report to estimate the probability of wolves crossing the ice to Michigan, assuming that the probability of crossing is proportional to the density of the Ontario wolf population.

Deer Study

After two winters of study, we have concluded that winter shipping does have an impact on normal deer movements and on deer survival. There remain questions, however, about whether deer movements in two winters with minimal winter shipping have resumed "base line" characteristics, about the number of deer affected, and whether the winter of 1980-81 with early heavy ice formation and early break-up with widely available grass for deer feeding was typical. Deer radio-tagged in February and March of 1981 continue to transmit signals. Information on their fall, winter, and spring movements could be obtained through continued monitoring. The life of the batteries is estimated at about three years.

In order to improve our information on the timing of deer movements, the number of deer migrating to and from Neebish Island, the number of deer making daily movements between St. Joseph and Neebish Island, and general nutritional condition and mortality of deer wintering on Neebish Island we recommend the following:

(1) Continue aerial and ground surveys using methods similar to those used in the 1980 and 1981 studies. Collection of crossing data should begin in December in order to determine whether deer cross the channel during December and early January.

(2) Continue to monitor radio-collared deer in order to determine when the animals move into the winter yard and the extent of their movements within the yard.

(3) Continue to trap, mark, and radio-collar deer. A larger sample size of marked deer is necessary to more accurately describe deer movements and numbers on Neebish Island. Portable Clover single-gate deer traps (Clover 1956) should be used along with the sliding-door box traps. Clover traps can be easily moved to new locations if unsuccessful in one area.

(4) Use solar-powered radio-transmitters that attach to a deer's ear. These may be more desirable than collars because of possible problems with radio-collars as growth of the deer occurs.

(5) Use pellet-group surveys (Bennett et al. 1940) to estimate deer numbers in the winter yard.

(6) Continue dead deer survey.

(7) Locate field headquarters for deer study on Neebish Island. Approximately three hours a day were spent getting to and from the study area. Living on Neebish Island would eliminate this travel time and problems associated with getting to the island during severe weather and at times when the ice bridge was unsafe to cross.

PART VII: CONCLUSIONS

1. Wolves along the Canadian shore of Whitefish Bay exist in low densities relative to densities found in interior Ontario, Isle Royale, and northern Minnesota.

2. Attempts of wolves to cross Whitefish Bay occur at an estimated frequency of about once per ten years.

3. Assuming stable or increasing numbers, wolves from a population inhabiting Cockburn Island 30 km east of the lower St. Mary's River are likely to attempt to cross the ship track once every one or two winters.

4. The estimated total number of mammal crossings of the St. Mary's River in January - March, 1981 was about 2/3 the estimated number that crossed the year before (1980). This could be a result of fewer coyotes and foxes present or an underestimate caused by poor tracking conditions in the winter of 1980-81.

5. An estimated 300-500 deer inhabit southern Neebish Island in winter.

6. Migration of deer from Sugar Island to Neebish Island is impeded by the ice ridges caused by winter shipping.

7. Local feeding excursions of about 10-15 deer between Neebish and St. Joseph Island occurred regularly and would be hampered by winter shipping.

8. In the winter of 1980-81, deer on Neebish Island fared well despite poor browse conditions probably because of mild weather in February and March, making grass available for feeding deer.

9. Spring migration from Neebish Island occurs mainly by deer swimming across the river after ice break-up.

10. Additional study would be directed at determining numbers and movement patterns of wolves on Cockburn Island and of deer movements and survival rates on Neebish Island.

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APPENDIX A

Personal communications concerning timber wolf populations in the Whitefish Bay and St. Mary's River study area.

Following are the names and addresses of the people within the study area who contributed to the development of the timber wolf distribution map (Figure 17). Some did not personally know the whereabouts of wolves, yet did know where wolves were not found.

Agawa, Jerry
Goulais Mission, Ontario

Anderson, Ian (Convervation Officer)
Kagawong, Manitoulin Island, Ontario

Archibald, Gene
RR #2 Prince
Sault Ste Marie, Ontario

Archibald, Robert
604 Walls Road
RR #1
Sault Ste. Marie, Ontario

Bailey, Arthur
Evansville, Manitoulin Is., Ontario

Bellow, Blaias
Garden River Indian Reserve, Ontario

Carrick, Ben Sr.
Bay Mills Reserve, Michigan
(906-248-3470)

Ceoli, Walter
Ministry of Natural Resources
Sault Ste. Marie, Ontario

Chartrand, Emmett
Bow 24 RR #1
Thessalon, Ontario
(705-842-5805)

Cress, Larry
RR #2 Tehkummak
Manitoulin, Ontario
(705-859-3755

Daigle, Alex and Ray
Gros Cap
Sault Ste. Marie, Ontario

Daniher, William
Ministry of Natural Resources
Sault Ste. Marie, Ontario

Digby, Earl
Batchawana Bay, Ontario

Dunn, Walter
Box 102
Thessalon, Ontario

Dyni, Sharow and Joseph
1560 Leighs Bay Road
Sault Ste. Marie, Michigan

Eikey, Wilfred
Route 2, Box 413
Sault Ste. Marie, Michigan

Folz, Ron (Ron's Baits)
HWY 17N
Sault Ste. Marie, Ontario

Gagne, Arman
2551 Baseline Road
Sault Ste. Marie, Ontario

Gjos, James
Desbarats, Ontario

Hanson, William
Searchmont, Ontario

Harris, Paul
Batchawana Bay, Ontario

Haviland, Raymond
Drummond
Drummond Island, Michigan

Holiday, Kitty
Searchmont, Ontario

Jackson, Ken
Ministry of Natural Resources
Espanola, Ontario

Jones, Dennis
Garden River Reserve, Ontario
(705-254-5967)

Jones, George
Pancake Bay Park, Ontario

Jones, Scott
Ministry of Natural Resources
Espanola, Ontario

Kelly, Lyle
Drummond Island, Michigan
(906-493-5581)

Kelly, Patrick
Drummond Island, Michigan
(906-493-5278)

La Perriere, Bradley
Pine Shore
Goulais Point, Ontario
(705-649-2270)

Lessard, Melvin
Iron Bridge, Ontario
(705-843-2179)

McClean, Robert
Mission Road
Goulais Point, Ontario
(705-649-5752)

McCoy, Hoot
Goulais Mission, Ontario

McDonald, Jerry
HWY 552
Goulais River, Ontario
(705-649-5244)

Mcleod, Ken
Poplar Dale, Ontario

Mitchell, Erwin
Box 478 Thessalon, Ontario
(705-842-3518)

Parish, Robert Sr.
Bay Mills Reserve, Michigan
(906-248-5176)

Pickard, Harmon
RR #1
Goulais River, Ontario

Rand, Richard (Fur dealer)
Rt. #1
Sault Ste. Marie, Michigan

Reed, James
St. Joseph Island, Ontario
(705-246-2100)

Roberts, Mark
Searchmont, Ontario

Rutledge, Robert
Goulais Bay, Ontario
(705-649-2258)

Sharpe, Wesley
2408 Second Line West
Sault Ste. Marie, Ontario

Smith, Sheen
Batchawana Bay, Ontario

Stone, Cedric and Dennis
Poplar Dale, Ontario

Varcoe, Rod
325 Sussex Drive
Sault Ste. Marie, Ontario
(705-254-3974)

Weston, Richard
Bay Mills Reserve, Michigan
(906-437-5400)

Wilcox, Woodword
Brimley, Michigan

Young, Edwin
65 Melrose
Sault Ste. Marie, Ontario
(705-256-6088)

Young, Frank
RR #2
Goulais River, Ontario